Report of an expert consultation workshop on

Sustainable Land Management (SLM) Regional Action Programme Formulation to Respond to Climate change in Synergy with the three Rio Conventions

2-3 September 2013, Asia Airport Hotel, Pathumthani, Thailand

Sponsored by

Food and Agricultural Organization of the United Nations

Organized by

Asian Institute of Technology

September 2013

Acknowledgements

An expert consultation workshop on "Sustainable Land Management (SLM) Regional Action Programme Formulation to Respond to Climate change in Synergy with the three Rio Conventions" sponsored by the Food and Agriculture Organization Regional office for Asia and the Pacific (FAO-RAP) was held during 2-3 September 2013 at the Asia Airport Hotel, Pathumthani, Thailand. The objective of the workshop was to formulate the Asia Soil Conservation Network Sustainable Land Management Regional Action Programme (SLM-RAP) to strengthen regional cooperation on SLM implementation and enhance synergy between initiatives in support of three Rio Conventions. The workshop participants came from more than ten countries of Asia. Two keynote presentations and nine country presentations were made with extensive time dedicated for group discussion by the experts on land degradation, sustainable land management and soil and water conservation. A regional action programme was drafted as the output of workgroup discussion.

Asia Soil Conservation Network for the humid tropics (ASOCON) and the Asian Institute of Technology (AIT) would like to thank Food and Agriculture Organization Regional Office for Asia and Pacific (FAO-RAP) for providing funding support for the workshop and Dr Yuji Niino, Land Management Officer of FAO, for his overall guidance to lead a successful workshop. Thanks are also due to the country participants for their enthusiastic active participation at the workshop. The support of Asian Institute Technology, staff colleagues in particular who provided necessary and timely support is also highly acknowledged.

Rajendra P. Shrestha
Theme Leader and Associate Professor
Society, Resources and Development thematic area
School of Environment, Resources and Development
Asian Institute of Technology

30 September 2013

Contents

Executive Summary

Land degradation and desertification, climate change and biodiversity loss are interconnected and hence effective solutions to address these issues demand coordination and synergistic activities through the action programs of the three Rio Conventions. There is the need to strengthen the implementation of UNCCD by the country Parties in Asia by intensifying regional cooperation on exchange of knowledge and best practices on combating desertification land degradation and drought (DLDD).

Asia Soil Conservation Network (ASOCON) represented by many countries in Asia has been involved in enhancing the skills and expertise of the development and dissemination of soil and water conservation and SLM practices for sustainable land use and management and productivity improvement. Most of the ASOCON national coordinators/focal points are also the focal points of UNCCD, and often UNCBD as well as UNFCCC. Besides, ASOCON also closely works with the World Overview of Conservation Approaches and Technologies (WOCAT), a global network of Soil and Water Conservation (SWC) specialists, contributing to sustainable land management (SLM).

One of the major resolutions of the WOCAT-ASOCON workshop organized from 26-28 March 2012 at Antipolo city, Philippines was to integrate and synergize the initiatives and activities of ASOCON within the region. Subsequently, a request for support from the Food and Agriculture Organization was made by ASOCON to organize an expert consultation workshop on Sustainable Land Management Regional Action Programme Formulation to Respond to Climate change in Synergy with the three Rio Conventions to produce a regional action programs. Hence, this workshop was organized with the objective of formulating the ASOCON SLM Regional Action Programme (SLM-RAP) to strengthen regional cooperation on SLM implementation and enhance synergy between initiatives in support of three Rio Conventions.

To review the lessons at regional and national level including the barriers to adopt soil and water conservation practices, existing best SLM practices and national action programs, regional level and country specific presentations from Bhutan, Indonesia, Mongolia, Pakistan, PR China, Philippines, Sri Lanka, Thailand and Vietnam were made. A major part of workshop was also dedicated for discussion and drafting an action program. The major findings of the presentations and workshop deliberations are given below.

The countries of Asia are experiencing rapid population growth with an ever increasing demand for food and other resources of basic necessities. As many as three-fourth of country's' population, e.g. in Indonesia, depend on agriculture (including livestock husbandry, such as in Mongolia), a sector which is also an important contributor to the national GDP. While arable land for good agriculture is limiting factor in most countries due to natural constraints in general, the countries like Bhutan and Mongolia have very limited arable land amounting to less than 3% of country's area and thus have to import a substantial proportion of their grain requirement from outside.

The major land degradation problems faced by the Asian countries are accelerated soil erosion mostly by water and also by wind, such as in Mongolia and China. As much as 70% of country's land area, e.g. in the Philippines, are affected by soil erosion due to water. Gullies in Bhutan, salinity in Indonesia and Pakistan, water logging, reduction in the productivity of dry land ecosystems including severe fertility decline, landslides and ravines are common land problems in the region. Compounded with growth-oriented development and competition in trade and investment which have contributed to the exploitation of natural resources beyond the carrying capacity of the ecosystem, the countries are also invariably exposed to climate change impacts on agriculture and other ecosystems through increasing number and magnitude of disasters, such as erratic rainfall, drought and flood in Sri Lanka, Thailand and Pakistan, and hailstorms in Bhutan. The Philippines is one of the most vulnerable to these impacts as it ranked highest in the world in terms of vulnerability to tropical cyclone occurrence and third in terms of people exposed to such seasonal events.

The extent of degraded land area is on the rise in many countries. For instance, 70% grasslands in Mongolia are severely degraded due to anthropogenic reason. The other such reasons are shifting cultivation (slash and burn), misuse of land resources, poor irrigation and drainage practice, and intensification of agriculture. This situation has been further causing land conversion from forests to cropland and pasture in the quest of increasing production eventually leading to land fragmentation making land uses practices unsustainable. The other associated problems, particularly in pastureland management, are typically of common property management, which include land tenure issue, overgrazing, free access to the surrounding forests, and non-equitable distribution of benefits. Lack of comprehensive national land use policy and updated land use plans and their poor enforcement, lack monitoring of land use conversion are adding to the problems, such as in the Philippines, whereas haphazard gem mining, lack of adequate land management practices are additional causes in Sri Lanka.

The adoption of soil and water conservation and sustainable land management has been slow due to number of barriers related to technology, policy, institutional and socioeconomic factors. These include low awareness among farmers, labor shortage, lack of information and financing, limited human and institutional capacities, tenure insecurity, lack of land use policies, weak of enforcement of environment laws and regulation and even lack or inadequate technologies, for instance in Mongolia.

There however exist number of promising and best SLM practices for conserving soil and water in many countries although their wider adoption is limited. Some of the best practices include terracing, hedgerows, contours, agroforestry or agro-sylvipasture, rainwater harvesting through Small Farm Reservoirs (SFRs) and Small Water Impounding Projects (SWIPs), Sloping Agricultural Land Technology (SALT), Natural Vegetative Strip **(**NVS), organic agriculture, conservation tillage (Zero Tillage), residue incorporation (Corn), and fertility improvement. There are also management systems successfully practiced in the region through collaboratory and participatory approaches that can contribute to SLM, specifically watershed management, forest management, pasture and range management, improvement of irrigation and drainage system.

With regard to policy framework and regulatory measures needed at the national level, all countries have dedicated government agencies with respective primary responsibilities of natural resources management and soil and water conservation established for several decades. Several national action programs on SLM exist in the countries, such as integrated soil fertility management or soil improvement, SLM for steep slope farming, irrigation system improvement and water resource development, rehabilitation of degraded/barren lands, crop suitability zoning, bio-technology and bio-engineering development, livestock and grazing management, forest fire management, institutional capacity strengthening. Aligning the national action programmes with ten year strategic plan of UNCCD through necessary revision is also under way by the Asian countries to meet the global mandate.

There are range of land degradation problems faced by the countries in Asia and sustainable land management exists as the solutions with regard to technical interventions and implementation approaches at local to regional scale. Recognizing the benefits of multi-function of land uses in addressing the issue of land degradation, biodiversity and climate change, participatory and holistic natural resource management has however gain momentum amongst the various stakeholders in past decades indicating increasing awareness of the people, the adoption of best SLM practices to realize the benefits fully is hindered by several barriers. Besides existing barriers which is further compounded due to climate change, the socioeconomic and political challenges specifically aging farmers, slow pace of agrarian reform in the face of rising land concession with little regulation and regional economic integration, e.g. ASEAN Economic Community, pose new dimensions to the future SLM actions in the region.

A lot of information and knowledge base as best practices exist in the region and beyond, including the tools and technologies from the global initiatives, like WOCAT, Land Degradation Assessments in Drylands (LADA), Desertification Mitigation and Remediation of Land – a global approach for local solutions (DESIRE), for local level adoption. These have to be appropriately scaled up for large scale adoption in view of synergistic benefits of conserving land and biodiversity, and mitigating climate change impact. This also calls for generating additional information on local level impact of climate change, and socioeconomic and environmental cost of land degradation, which are lacking at present. Emphasis on integrated ecosystem approach with community-based resource management with participation of all stakeholders including corporate sectors, reorganizing legal rights and land use governance, enhancing financial and supportive capacity, and developing comprehensive action plans relating to land degradation, biodiversity and climate change should be of high priority for the immediate future.

To contribute to these noble objectives of the three Rio Conventions, there is the need for strengthening/promoting national and regional networks for experience sharing by updating and documenting the knowledge, raising advocacy and awareness, building and transferring the SLM capacity, and supporting the formulation of enabling policy for implementation through a regional platform, like ASOCON. The workshop came up with a draft *Five-Year ASOCON Regional Action Programme for Sustainable Land Management in Asia 2014-2018*, which will be finalized within 2013. The agreed priority areas and activities of regional cooperation on Food and livelihood security in the ASOCON Regional Action Program are:

a) Land degradation
   i. Improvement of water use/management
   ii. Combating soil erosion
   iii. Address land tenure issues
   iv. Land use
   v. Agro-forestry and management of forest resources and watershed management
   vi. Reduced water logging and salinity
   vii. Pasture/range land management
   viii. Labour saving technology and make agriculture attractive
b) Climate change
   i. Establishment of early warning systems/climate resilient agriculture
   ii. Economic capacity building of local communities
   iii. Alternative livelihood
   iv. Avoiding deforestation
   v. Improvement soil as carbon sink
c) Biodiversity loss
   i. Valuation of ecosystem services/development of eco- and ethno-tourism
   ii. Economic capacity building of local communities
   iii. Promote ecosystem based agriculture.

1. Introduction

It is recognized that land degradation and desertification, climate change and biodiversity loss are interconnected and reinforce each other. The Rio+20 also stressed that desertification, land degradation and drought are challenges of a global dimension and continue to pose serious challenges to the sustainable development of all countries, in particular developing countries, and called for urgent action through short-, medium- and long-term measures at all levels.

It is important that country Parties in Asia strengthen the implementation of the UNCCD by intensifying regional cooperation on exchange of knowledge and best practices on combating desertification land degradation and drought (DLDD). In this respect, an effective regional solution demands coordination and synergistic actions through the action programs of the three Rio Conventions.

Asia Soil Conservation Network for the Humid Tropics (ASOCON), a regional network of Asian Countries, has been involved in enhancing the skills and expertise of the development and dissemination of soil and water conservation and sustainable land management (SLM) practices for small-scale farmers for sustainable land use and management and productivity improvement and thus can effectively contribute to the formulation of Regional Action Programme that will strengthen regional initiatives on SLM and to achieve synergy between the three Rio Conventions.

The major objective of the workshop was to formulate the ASOCON SLM Regional Action Programme (SLM-RAP) to strengthen regional cooperation on SLM implementation and enhance synergy between initiatives in support of three Rio Conventions. As the expected output, a five-year ASOCON SLM Regional Action Programme (SLM-RAP) was agreed and drafted, which will be further revised and finalized for implementation by mid 2014.

2. Participants

Participants were the ASOCON member experts, UNCCD country focal points, and experts on DLDD and SLM from Asia countries representing more than ten countries, namely Bhutan, China, Indonesia, Maldives, Mongolia, Nepal, Pakistan, Philippines, Sri Lanka, Thailand, and Vietnam. The participants list is given in Appendix 1.

3. Workshop Program and Deliberation

The workshop program (agenda) is given in Appendix 2. The workshop was jointly opened by S. Kumar, Professor and Vice President for Academic Affairs of the Asian Institute of Technology, and Vili Fuavao, FAO Deputy Regional Representative for Asia and the Pacific. Below is a brief summary of the workshop deliberation.

Mr. S. Kumar welcomed the participants and emphasized the need of sustainable land management in the face of increasing land degradation in Asia. Issue of land degradation is specially important in Asia as there is no opportunity for agricultural extensification to meet the increasing food demand. AIT with its mission in higher education and research has also been actively engaged in generating information and developing human resources in the areas of land degradation studies and sustainable land management among others to serve the region better. He stated that this workshop is very timely and appropriate platform for such exchange of knowledge in dealing with future problems by developing realistic and achievable action programs for soil and water conservation that could bring synergistic impact serving the objectives of three Rio conventions.

While welcoming the participants, on behalf of Mr. Hiroyuki Konuma, Assistant Director-General and FAO Regional Representative, Mr. Vili Fuavao, FAO Deputy Regional Representative for Asia and the Pacific mentioned that there are many benefits of SLM in meeting nutrient requirements of the people, maintaining ecosystem productivity and services, and eradicating hunger but adoption of SLM practices have been slow globally. ASOCON as regional network which can contribute to these objectives and there is the need of having clear vision and goals with regional action programs and hence the workshop was very timely. Mr Konuma's full speech is given in Appendix 3.

Yuji Niino, Land Management officer of FAO-RAP, presented the objectives and expected outputs of the expert consultation workshop. The objectives of this expert consultation workshop in collaboration with ASOCON members are to review the existing national and regional action programmes to combat desertification, land degradation and drought (DLDD) as baseline document, and to formulate the ASOCON SLM Regional Action Programme (SLM-RAP) to strengthen regional cooperation on SLM implementation and enhance synergy between initiatives in support of three Rio Conventions. The expected output was a draft ASOCON SLM Regional Action Programme (SLM-RAP) formulated and implementation plan discussed and agreed. Rajendra Shrestha of the Asian Institute of Technology served as the master of

ceremony for the welcome session. Shafia Aminath facilitated the rest of the workshop sessions on country paper presentation and group discussion, and plenary sessions.

3.1 Keynote paper presentation -1

Mr. Samuel Contreras gave a presentation on "Overview of land degradation and conservation measures in Asian Context" as keynote paper on behalf of WOCAT team (Isabelle Providoli and colleagues). This presentation included the concept of land degradation and the Sustainable Land Management (SLM); introduction to the World overview of conservation approaches and technologies (WOCAT) methods, achievements and network partners including ASOCON; its link Rio convention UNCCD in particular, and the network activities in Asian context. Presentation slides are included in Appendix 4.

3.2 Keynote paper presentation -2

Mr. Eduardo Queblatin gave a presentation on "Sustainable land management: some emerging good practices and institutional innovations in the region". Starting with the link between three Rio conventions, his presentation covered emerging challenges that impact on SLM efforts, policy situation, SLM capacity building emphasizing community based management, and integrated ecosystem approach as emerging trends and innovations. Some recommendations made included updating of national action plans, adopting landscape approaches by working with local authorities citing examples from Australia and the Philippines, addressing agrobiodiverstiy needs, engaging corporate sectors and integrated financing. ASOCON could play an important role as a bridge to strengthen these various objectives of integrated management, conservation concerns and agrobiodiveristy, and land governance. Presentation slides are included in Appendix 5.

3.3 Country presentations

The participating country representatives gave presentation of their respective country report. The country report was asked to prepare according the content outline (Appendix 6) which was provided by the organizers in advance and almost all the countries followed the provide outline to prepare their country papers. The paper mainly contained the country level situation analysis, barriers to adoption of soil and water conservation including in the context of climate change, best management practices in soil and water conservation, national action programs on soil and water conservation, and conclusions/recommendations. Below is the brief summary of the country papers. Full length country papers are presented in Appendix 7.

Bhutan: Seventy percent of Bhutan's area is covered by forest and the country is rich in biodiversity and water resources. Arable land of Bhutan is about 3% of country's area yet 69% of the Bhutan's population depend on agriculture. More than 50% of the country's grain requirement depend on import. Majority of Bhutanese population are subsistence small and marginal farmers constrained with inadequate land holdings and inaccessibility to market and technology. Land degradation is becoming an important issue in Bhutan because of its adverse impact on agronomic productivity, the environment, and consequently on food security and the quality of life. Being mountainous country, the land degradation problems like soil erosion and even huge gullies, landslides and ravines and severe soil fertility decline are the major ones. Overgrazing, unsustainable agricultural practices, construction of infrastructure without proper environmental measures and including mining are the major causes of the problems. Bhutan is already exposed to natural and climate related disaster such as drought, strong wind, late and early rainfall patterns, temperature variations, hailstorm, flooding and earthquake in recent times and this has further challenged the buffering capacity in agricultural systems against climatic variation and attaining food security. Barriers to adoption of sustainable land management practices are low awareness among farmers, limited land holding and type of farming systems practiced, labor shortage, lack of information, limited human and institutional capacities, lack of land use policies, weak of enforcement of environment laws and regulation. Some of the best management practices being practiced are terracing, hedgerows, contours, agroforestry. Bhutan has implemented its national development plan since 1961 and there are several action programs at present, such as include integrated soil fertility management, SLM for steep slope farming, irrigation system improvement, rehabilitation of degraded/ barren lands, livestock and grazing management, forest fire management, strengthening institutional capacity.

Indonesia: Land degradation, climate change and biodiversity loss is likely to have a significant impact on Indonesia. Land degradation is a major cause of the expansion of crop and pasture lands to the detriment of existing forests as three-fourth of country's population depend on agriculture. Almost all new crop land came from clearing of primary and secondary forests. The Indonesian agriculture is facing serious problems, such as: 1) productivity decline, 2) soil and water degradation, specially reduced fertility and pollution, 3) flood and drought due to climate change which caused agriculture production decrease, and 4) conversion and fragmentation of agriculture land. Land degradation includes accelerated soil erosion by wind, water, increasing salinization of soils and near surface ground water supplies, reduction in the productivity of dry land ecosystems resulting in the impoverishment of the communities dependent on these ecosystems. The extent of degraded land in Indonesia is increasing rapidly especially in the dry areas due to shifting cultivation, misuse of land resources, and overgrazing. Climate change is projected to have significant impact both on agriculture, forest and coral ecosystems and even human health. Barriers to adopt soil and water conservation measures are related to technology, policy, institutional and socioeconomic factors. Agro-sylvipasture system is considered as the most appropriate farming systems for sustainable land management (SLM) and combating land degradation and alleviating poverty in Indonesia. Programme on soil and water conservation in Indonesia has been formulated in

national action programme to combat land degradation. Currently the number of action programmes are under revision process to be aligned with ten year strategic plan of UNCCD as a global mandate.

Mongolia: Agricultural sector, especially livestock husbandry is one of the main sectors in Mongolian economy contributing 21 percent of GDP. Land for crop farming is relatively little in the country and the main reasons for soil degradation in agricultural land are due to climate's influence as well as lack of soil conservation technology. Mongolian rangeland is vast, but very vulnerable, and it occupies 112.8 million hectares or 72.1 percent of the total territory. About 70% grasslands providing forage for the livestock are severely degraded due to natural factors such as climate changes that have already occurred, and factors mainly caused by human behavior such as taking advantage of free grazing and access to water without managing this natural resource in a sustainable way. The root causes of the pasture degradation are open access and the collapse of herders organizations after the introduciton of market economy since 1990. Because the Mongolian conditions make seasonal and inter-annual movement of livestock a necessity, privatization of the rangeland is not possible, and reducing open access via collective action is the only way to reduce pasture degradation. To adapt to climate and social change or to sustain and develop their life, a single herder household can't use pasture land separately in pastoral, nomadic, livestock husbandry. It requires that herders must cooperate together as herders' community for managing rangeland. Therefore, the establishment of territory based, herders' self-governing organizations is the main ways and means of solving numerous urgent problems of developing agriculture and rural society in Mongolia. The issues of enhanced legal rights and collaboration from local government authorities to enforce the decisions in their pasture management plans are of immediate concerns.

Pakistan: Pakistan inhabits more than 180 million people with annual population growth of 2.6 percent. This fast growing population has put tremendous pressure on the existing natural resources in terms of food production, cash crops, water, animal rearing, timber, fuel-wood, fodder and other non-timber forest products especially medical plants. Out of the total area of 79.6 million ha of Pakistan, only 20 million ha are suitable for agriculture. Water logging, and salinity are the major land degradation problems in agricultural area, while deforestation and desertification are also prominent problems in the country. The main causes of the land degradation in Pakistan include poor irrigation and drainage system, intensification of agriculture, removal of vegetation cover (deforestation), overgrazing, increased competition for water, drought, shifting cultivation, frequent flooding, population pressure and above all the high level of poverty. 5 million ha of rangelands have been lost in 10 year period in the country. Deforestation and over grazing are major problems. Other associated problems in pasture management are; land tenure; overgrazing, non-uniform grazing, free access to the surrounding forests, accelerated erosion, and weed, while the major social issue is the non-equitable distribution of benefits, as there is no restriction on the number of the livestock. A number of key barriers to the adoption of soil and water conservation are at various levels and encompass the following main categories; policy barriers, institutional

barriers, socio-economic barriers, and the non-availability of timely and appropriate information. Some of the best management practices for soil and conservation include; collaborative watershed management, sustainable forest management (participatory management planning, joint forest management, and social forestry) participatory pasture and range management, LADA, improvement of irrigation and drainage system, Farmer Field School, women open schools, agro-forestry and farm forestry, Disaster Risk reduction and mitigation measures including bio-engineering. These best practices have been applied and adopted upto a certain level in various disaster prone sites. However the large scale replication and adaptation is still a major issue. Over the last 20 years the participatory and holistic natural resource management has gain high priority amongst the different stakeholders. Similarly the multiple land-use concepts are also getting importance, which are used in the natural resource planning. Unlike the past, the forestry resources are now considered to provide various products, services and functions, and the management is not centered on trees. There are number of national action programs on soil and water conservation being implemented in the country, however efforts should be made for collecting systematic information about the land degradation, adopting LADA approach, proper land use planning and establishing/promoting National and Regional networks for experience sharing.

PR China: With rapid social and economic development and increasing population, china faces more and more pressures and demand on water resources and ecosystem in general. Water pollution and soil erosion still continue to be the major degradation problem in near future. The total area of soil and water erosion reaches 2.95 million km^2, occupying 30% of the total territory, and almost all the provinces suffer from soil and water erosion in various levels. Soil and water erosion exists not only in rural areas, but also in cities, development zones and industrial and mining areas. The soil and water erosion is degrading land and damaging farmland. During the recent 50 years, the damaged farmland due to soil and water erosion reaches over 3 million ha. At current water and soil erosion rate, top layer of black soil in more than 900,000 ha. of the northeast may become thinner after 50 years, and rockification area may expand in the southwest. China has been aware of these challenges and takes ecological civilization building as the long term national strategy. Population growth, shortage of resources, limited environmental capacity, over cutting of forests, over reclamation and over grazing, and unreasonable utilization of water resources in the long history. The impact of climate change, and extreme weather conditions have also been witnessed in China. As the barriers, the amount of eroded land is so large and very dispersive that financing can hardly be sufficient. Similarly, insufficient capabilities and technologies on quantity and quality monitoring and assessment, lack of awareness and knowledge of farmers, economic incentives to the unreasonable exploitation and construction activities are other barriers. There are successful examples of holistic and integrated management, particularly small watershed (10-50 km^2) as a conservation unit, and some 50,000 watersheds were managed or are currently under management. This has been possible due to continuous implementation of national key projects on soil and water conservation in most fragile areas.

Philippines: The Philippines is well endowed with natural resources and is known to host many interesting habitats that are biologically diverse and composed of universally unique plant and animals. However, because of complex conditions due to increasing population, stagnation of rural economy, diverse culture, isolated small islands and its geographical setting, various forms, sources and severity of environmental degradation occurred in the last five decades. The most dominant form of land degradation in the Philippines is soil erosion accounting some 70% of the country's land area. About 45% of the country's area is moderately to severely eroded. The causal factors range from natural factors to anthropogenic factors, specially absence of a comprehensive national land use policy and updated land use plans; poor enforcement of land use policies and monitoring of land use conversion. Climate projection scenarios indicate that the Philippines is one of the most vulnerable to these impacts as it ranked highest in the world in terms of vulnerability to tropical cyclone occurrence and third in terms of people exposed to such seasonal events. There are number of best management practices of soil and water conservation measures, e.g. Rainfed paddy rice terraces, Rainwater harvesting through Small Farm Reservoirs (SFRs) and Small Water Impounding Projects (SWIPs) for rainwater and runoff management, Sloping Agricultural Land Technology (SALT), Natural Vegetative Strip **(**NVS), Organic Agriculture, Conservation Tillage Technology (Zero Tillage), Residue Incorporation (Corn), agroforestry. The major barriers in adoption are inadequate technologies, tenure insecurity, socioeconomic and Institutional factors. There are government agencies with respective primary responsibilities, such as DENR, BSWM and local governments who are mandated to address the problems in natural resources and soil and water conservation through national action programs. On February 24, 2011, the implementation of the National Greening Program (NGP) was declared as the government priority program to reduce poverty; promote food security, environmental sustainability and biodiversity conservation; and climate change mitigation and adaptation.

Sri Lanka: Agriculture in Sri Lanka plays a key role in the country's economic development as 40% of the country's land area is occupied by agriculture. Coconut, tea and rubber together account for 42.5%. Recent estimates indicate that 50% and 30% of agricultural lands in Sri Lanka have been degraded due to soil erosion and declining soil fertility respectively. Haphazard gem mining, cultivation, lack of adequate land management practices in agricultural lands, deforestation and inadequate land use planning are also the causes of human induced soil erosion in the country. Chena or slash and burning cultivation is also a major problem affecting land degradation in the Dry Zone. Impact of soil erosion has substantial socio-economic cost. For example, on-site cost due to nutrient loss alone is estimated to be Rs 953 million from the Upper Mahaweli Watershed, besides less water retention capacity that aggravates the impact of drought on crop yields. On average Sri Lanka faces drought conditions every 3-4 years, however the occurrence is increasing in recent few decades. There is lack of in-depth studies on impact of climate change in the country. Some studies have indicated that many typical farming districts such as Nuwara-Eliya, Ratnapura, Anuradhapura, Badulla, Matale and Polonnaruwa are more sensitive to climate change than the rest of the country. There exist national policy framework and several important projects and programmes have been implemented by the line Ministries.

The soil and water conservation program have been implemented in Sri Lanka as a component in more holistic watershed management programmes in the past including through soil and water conservation interventions which led to improved soil fertility, reduced inorganic fertilizer application, and increased irrigation interval with higher water use efficiency. Among the barriers to adoption of soil conservation, the constraints like technological, policy, economic, institutional are the major ones.

Thailand: Growth-oriented development and competition in trade and investment have contributed to the exploitation of natural resources beyond the carrying capacity of the ecosystem in Thailand. Forest areas have been damaged or destroyed, disrupting the balance of the ecosystem and endangering biodiversity. 20% of forest area lost in less than 50 years of time. Soil has deteriorated while conflicts over land use continue. Soil resources, a major production element, have been compromised through inappropriate use and improper distribution. Land areas degraded to a severe and critical level cover 11.2 percent of the country. Natural disasters, such as flood and drought are more frequent and severe. Soil erosion by water, problem soils are among the major soil related problems in the country. Watershed management, SALT, fertility improvement are some of major best management practices practiced in the country. Since 1961, Thailand's five-year national economic and social development plans have provided a framework for sustainable development. National Action Programme for Combating Desertification is constituted as strategic plan of the Ministry of Agriculture and Cooperatives to support sustainable land management with special projects, such as Land rehabilitation and soil improvement, Water resource development, Zonation of suitable soils for cropping, Strengthening and capacity building of sub-district and village Volunteer Soil Doctors, Implementing demonstration plots and establishing one agriculture learning center for each sub-district, Provision of soil analysis service, Development of soil Information systems to serve farmers' requirements by conducting land development and bio-technology research to increase crop production.

Vietnam -1: Managing Vietnamese soils to respond to climate change: Improve soil carbon stock and GHG mitigation in rice production.

This paper reported the results of organic carbon study in term of total concentration of more than 1200 soils samples collected in six main great groups of Vietnamese soils: Fluvisols; Acrisols (degraded soils); Ferralsols; Arenosols (sandy soils); Acid sulfate soils; and Saline soils out of 14 major great group of soils in Vietnam. The results showed that, Acid sulfate soils had highest organic carbon content with the mean of 3.80 %; Ferrasols had an organic carbon content of 2.22 (%) in the second place followed by Fluvisols (1.99 %) and saline soils (1.72%) and Acrisol (1.08 %). The organic carbon content in sandy soil (Arenosol) was the lowest (0.68%). Organic carbon and therefore carbon stocks in soils were much closed correlated with soil texture and agricultural practices. General tendencies of carbon stock in Vietnamese soils are slowly decreasing in the area under annual cropping systems, especially in cash crop and vegetable farming.

Vietnam -2: A climate-smart rice production in Vietnam: promising GHG Mitigation options.

Agriculture plays a very important role in Vietnam economy with more than 70% engaged population and 20-24% in GDP. Signs of climate change affecting agriculture production and farmer's income have been identified not only by scientists but by both local authorities and farmers. Rice production in Vietnam increased by nearly four times in last five decades both due to increased crop yield (2.51 times), and cultivated area (1.53 times). Vietnam is now the second world rice exporter with a total about 4-5 million tons of rice annually. As rice production areas in Vietnam are located mainly in Mekong River Delta (MRD) (51%) and Red River Delta (15%), these zones are considered the most affected by climate changes, in which, high sea level rises have been forecasted. In worst case scenario, more than 1.1 million ha of rice land in MRD will be deeply submerged including salinity intrusion. In addition, extreme climate such as heavy storms, irregular rainfalls distribution; droughts, unpredicted disease epidemics are big challenges for Vietnam to keep a stable rice production in the end of this century. Different measures and actions for mitigation and adaptation are taken into consideration in Vietnam. Promising solution should be taken to reduce the amount of chemical conventional fertilizers application and to use environment friendly nutrients from organic and inorganic sources, to develop and use new type and new technique of fertilization such as bio-char, wet and dry alternative irrigation in rice production integrated with minimum tillage and mix cropping systems.

3.4 Breakout group discussion

The participants were divided into two groups to brainstorm and draft regional action programs. The discussion were led by pre-identified Group chair and assisted by rapporteur. Work of groups were discussed in a plenary participated by all participants and further discussed in separate groups followed by final plenary. An outline for discussion was provided to guide the group discussion in proper direction so that regional action program could be produced. The groups are able to identify and agree major action programs of regional importance for ASOCON activities. The agreed objectives, priority areas and activities are listed below. The detail **Notes to first draft of RAP** is included in Appendix 8.

Five-Year ASOCON Regional Action Programme for Sustainable Land Management in Asia 2014-2018 [draft]

1. *Objectives of regional cooperation*

   Strengthen regional cooperation to address the common issues

   i. Advocacy, awareness raising, (visibility) and education to influence policy and decision makers
   ii. Support the formulation of enabling policy for implementation
   iii. Update and documentation of knowledge on climate change and its impact
   iv. Capacity Building and technology transfer – identify and address capacity building needs
   v. Resource mobilization and financing

2. *Priority areas and activities of regional cooperation on Food and livelihood security*
   d) Land degradation
      i. Improvement of water use/management
      ii. Combating soil erosion
      iii. Address land tenure issues
      iv. Land use
      v. Agro-forestry and management of forest resources and watershed management
      vi. Reduced water logging and salinity
      vii. Pasture/range land management
      viii. Labour saving technology and make agriculture attractive

   e) Climate change
      vi. Establishment of early warning systems/climate resilient agriculture
      vii. Economic capacity building of local communities
      viii. Alternative livelihood
      ix. Avoiding deforestation
      x. Improvement soil as carbon sink

   f) Biodiversity loss
      iv. Valuation of ecosystem services/development of eco- and ethno-tourism
      v. Economic capacity building of local communities
      vi. Promote ecosystem based agriculture.

The document will be further expanded by ASOCON secretariat by including rationale, mechanism of implementing actions, timeframe and estimated budget for each action. Samuel Contreras will coordinate the activities on behalf of the ASOCON secretariat. A small expert's group meeting will be planned in October 2013 to revise/refine the draft action plan in ASOCON secretariat. It was agreed that the regional action program document will be finalized before June 2014. Then it could be submitted as the ASOCON Proposal to FAO-RAP for consideration in exploring and assisting with funding opportunities.

4. Closing Session

In closing session of the expert consultation workshop, Samuel Contreras representing ASOCON mentioned that the workshop provided a good opportunity and experience interacting several experts from the region on the issue of soil and water conservation and the workshop outcomes are useful for determining the ASOCON activities. Yuji Niino from FAO-RAP thanked the participants for their active participation and AIT for organizing the workshop. He opined that the workshop well achieved its set forth objectives to identify the regional needs in developing ASOCON action programmes. There is a need of ASOCON activities to bring to another level achieving sustainable land management in the region. Rajendra Shrestha representing the Asian Institute of Technology mentioned that the workshop provided a learning experience linking with ground realities through the SLM experts and thanked participants for active participation and ASOCON for assisting in conceptualizing and management of workshop and FAO-RAP for funding support.

Appendices

Appendix 1: List of Participants

SN	Name	Country	Address
1	Mr. Samuel Contreras	Philippines / ASOCON Secretariat	Bureau of Soils and Water Management SRDC Bldg., Elliptical Road, Diliman, Quezon City Tel.: +63-2-9230459 E-mail: sammycontreras@yahoo.com
2	Dr. Syaiful Anwar	Indonesia	Ministry of Forestry Gd. Manggala Wanabakti Blok I Lt. 13 Jakarta Tel.: +62-21-5730151 E-mail: syaifula09@gmail.com
3	Dr. Pham Quang Ha	Vietnam	Institute for Agricultural Environment PhuDo-Tuliem, Hanoi Tel.: +84-923342479; 0437893270 E-mail: pqha-nisf@hn.vnn.vn
4	Mr. Chinapatana Sukvibool	Thailand	Director, Div. of Soil and water Conservation, Land Development Department Chatuchak, Bangkok 10900 Tel.: +66-89-212-7542, E-mail: sukvibool@hotmail.com
5	Prof. Nimal Gunawardena	Sri Lanka	Agric. Engineering, Faculty of Agriculture University of Peradeniya E-mail: nimalgun@pdn.ac.lk
6	Ms. Wang Ying	China	Ministry of Water Resources, No.2, Lane 2, Baiguanlu Xuanwu District, Beijing 100053 Tel. +86-10-63202846; +86-18611035318 E-mail: wying@mwr.gov.cn
7	Ms. Yeshey	Bhutan	Research Officer RNRRDC Bajo, Department of Agriculture Ministry of Agriculture and Forest Tel.: +975-2-351182; 2-351037 E-mail: yesheyrcb@yahoo.com
8	Prof. Dulamsuren Dorligsuren	Mongolia	Executive Director Mongolian Society for Range Management Tel.: +976-11-453757 E-mail: dorligsuren@msrm.mn
9	Dr. Faizul Bari	Pakistan	Project Coordinator Gul Mohar Lane, University Town Peshawar Tel.: +92-915702231, 2 (work); +92-3458544116 (Mobile) E-mail: faizul.bari@fao.org
10	Mr. Eduardo Queblatin	Philippines	Board Member Philippine Watershed Management Coalition(PWMC) www.philwatershed.net E-mail: equeblatin@gmail.com
11	Dr. Shafia Aminath	Maldives / Facilitator	M. Park Lane, Majeedhee Magu Male, Maldives E-mail: ashafia@hotmail.com; shaf0015@gmail.com
12	Dr. Yuji Niino	Japan	Land Management Officer, FAO-RAP Bangkok, E-mail: yuji.niino@fao.org
13	Dr. S. L. Ranamukhaarachchi	Sri Lanka	SLM Consultant, FAO-RAP Bangkok, E-mail: ranamuka@gmail.com
14	Dr. Rajendra Shrestha	Nepal	Associate Professor and Theme leader, Asian Institute of Technology, Bangkok, E-mail: rajendra@ait.ac.th

Five staff and graduate students from the Asian Institute of Technology were also present at the workshop for providing need support.

Appendix 2: Workshop Program

Day 1	**Monday (2 September 2013)**	
Time (hr)	**Activity**	**Presenter**
0800-0830	Registration	Workshop staff
0830-0900	Welcome Remark Welcome Remark Workshop Objectives and Expected Outputs Introduction of Participants	*MC: Rajendra Shrestha* **S. Kumar**, Vice President for Academic Affairs, AIT **Vili Fuavao**, Deputy Regional Representative, FAO-RAP **Yuji Niino**, FAO-RAP Participants
0900-0905	*Break for Photo session*	
0905-0930	**Keynote presentation 1** Overview of land degradation and conservation measures in Asian Context	*Facilitator: Shafia Aminath* **Samuel Contreras** for WOCAT
0930-1030	**Country paper presentation (10 min. presentation + 5 min. Q&A)** - Indonesia - Vietnam - Philippines - Bhutan	*Shafia Aminath* **Saiful Anwar** **Pham Q Ha** **Samuel Contreras** **Yeshey**
1030-1045	**Tea/Coffee Break**	
1045-1200	**Country paper presentation continued** - China - Mongolia - Pakistan - Sri Lanka - Thailand	*Shafia Aminath* **Wang Ying** **Dualmsuren Dorligsuren** **Faizul Bari** **Nimal Gunawardena** **Chinapatana Sukvibool**
1300-1400	**Lunch**	
1400-1430	**Keynote presentation 2** Some emerging good practices on institutional innovations for SLM in the region	*Shafia Aminath* **Eduardo Queblatin**
1200-1300	Third Draft of RAP to combat desertification in Asia and Pacific	*Shafia Aminath* **Saiful Anwar**
1430-1530	**Breakout sessions for formulation of the ASOCON SLM Regional Action Programme (SLM-RAP)** Guidance for discussion and content of SLM-RAP introduced • **Group 1** (policies, information and planning, institutional framework, budget) • **Group 2** (land resources use and management, decision making, priority technical areas, inputs, M&E)	*Shafia Aminath* **Yuji Niino** **Group chairs and rapporteurs from each group**
1530-1550	**Tea/Coffee Break**	
1550-1700	Breakout session continued	*Shafia Aminath* **Group chairs and rapporteurs from each group**
1800-2000	**Cocktail reception**	

Day 2	Tuesday (3 September 2013)	
0830-0900	Recap of first day group work by presenting progress/outcome and a plan of group work	*Shafia Aminath* **Group chairs and rapporteurs from each group**
0900-0940	Discussion and adjusting the directions	All Participants
0940-1030	Resume breakout session in drafting ASOCON SLM-RAP	*Shafia Aminath* **Group chairs and rapporteurs from each group**
1030-1050	**Tea/Coffee Break**	
1050-1200		*Shafia Aminath* **Group chairs and rapporteurs from each group**
1200-1300	**Lunch**	
1300-1500	Presentation and consolidation of ASOCON SLM-RAP followed by A Plenary (discussion and continuation of consolidating and finalizing the ASOCON SLM-RAP)	*Shafia Aminath* **Group chairs and rapporteurs from each group**
1500-1520	**Tea/Coffee Break**	
1520-1640	Plenary continued with discussion for way forward and work planning for SLM-RAP implementation	*Shafia Aminath* **Group chairs and rapporteurs from each group**
1640-1700	Closing session - Remarks from Participants - Closing remark - Closing remark	 ASOCON Secretariat (Samuel Contreras) FAO-RAP (Yuji Niino) AIT (Rajendra Shrestha)

Appendix 3: Welcome Address of Hiroyuki Konuma

Assistant Director-General and FAO Regional Representative for Asia and the Pacific delivered by **Vili Fuavao** Deputy Regional Representative FAO Regional Office for Asia and the Pacific at the Expert Consultation Workshop on Sustainable Land Management (SLM) Regional Action Programme Formulation to Respond to Climate Change in Synergy with the Three Rio Conventions 2 to 3 September 2013 Bangkok, Thailand

Mr Kumar, Vice President for Academic Affairs, AIT
ASOCON members,
Distinguished Colleagues,
Ladies and Gentlemen,

On behalf of Mr Hiroyuki Konuma, Assistant Director- General and FAO Regional Representative for Asia and the Pacific, I am pleased to welcome you all to Thailand and to this expert consultation workshop on sustainable land management regional action programme formulation.

It is a great honour for me to welcome you to this important forum. Before I begin, I would like to extend my thanks to AIT for organizing this workshop. I welcome your collaboration in supporting promotion of sustainable land management under the challenges of climate change for sustainable development in Asia.

As you are all aware, climate change presents a daunting challenge for Asia. Already, over the last fifty years, the region has experienced a range of observed climate changes including: declining precipitation, increasing water scarcity, rising average temperatures and the growing frequency of extreme weather events such as storms and floods. These changes, and those yet to come, pose a real and undeniable threat to the agro-ecosystems and natural resources that underpin the region's agriculture sector as well as to the livelihoods of its rural communities and, by extension, to food security. Given this threat, it should come as no surprise that coping with the impacts of climate change on agriculture, food and nutritional security is one of FAO's five strategic priorities for the region.

Climate change will complicate and compound the already existing development problems in the region such as population growth, rapid urbanization, increasing competition for natural resources, environmental degradation and, most importantly, food insecurity. Natural resource constraints, including limited availability of productive land and water, and stagnating agricultural productivity in some parts of the region, mean that we will need to work even harder in the future to eliminate remaining food insecurity.

Unacceptable levels of environmental damage and problems of economic feasibility are cited as key problems of modern agriculture practices. Greater attention is being given to alternative means of intensification, particularly the adoption of sustainable land management (or SLM) technologies. Key benefits of these technologies are increased food production without further depletion of soil and water resources, restoration of soil fertility, increased resilience of farming systems to climatic risks, and improved capacity to sequester carbon and mitigate climate change.

SLM technologies can generate both private and public benefits, and thus constitute a potentially important means of generating "win-win" solutions to addressing poverty and food insecurity as well as dealing with environmental issues. In terms of private benefits to farmers, by increasing and conserving natural capital – including organic soil matter, various forms of biodiversity and water resources – SLM can generate productivity increases, cost decreases and greater stability of production. SLM practices contribute to improving soil fertility and structure, adding high amounts of biomass to the soil, causing minimal soil disturbance, conserving soil and water, enhancing activity and diversity of soil fauna, and strengthening mechanisms of elemental cycling. This in turn translates into better plant nutrient content, increased water retention capacity and better soil structure, potentially leading to higher yields and greater resilience, thus contributing to enhancing food security and rural livelihoods.

At the same time, widespread adoption of SLM has the potential to generate significant public environmental goods in the form of improved watershed functioning, biodiversity conservation and Climate Change mitigation. The technical potential for mitigation from agriculture by 2030 is estimated to be between 4,500 MtCO2e/year and 6,000 MtCO2e/year, which can be reached by reducing greenhouse gas emissions – of which agriculture is an important source representing 14 percent of the global total – and increasing soil carbon sequestration, which constitutes 89 percent of agriculture's technical mitigation potential. Many SLM technologies can increase the levels of soil organic matter, of which carbon is the main component, therefore delivering significant Climate Change mitigation co-benefits in the form of reduced greenhouse gas emissions and increased carbon sequestration. Improving productivity would also reduce the need for additional land conversion to agriculture, which on its own represents almost as much greenhouse gas emissions as those directly generated from agricultural activities.

Despite the capacity to generate both public and private benefits, the adoption of SLM practices has been relatively slow globally. Thus, there is considerable interest in a better understanding of the benefits, costs and barriers to adoption of these practices.

This expert consultation workshop will address these issues and challenges for an effective regional solution and synergistic actions through formulation of ASOCON Action Programmes for the SLM which is to contribute to the three Rio Conventions. Through your interactions and collaboration over the coming two days, I hope that we will produce a clearer vision of how ASOCON can move beyond a blueprint to a programme of action with tangible and lasting impacts for sustainable and climate resilient agriculture in the region.

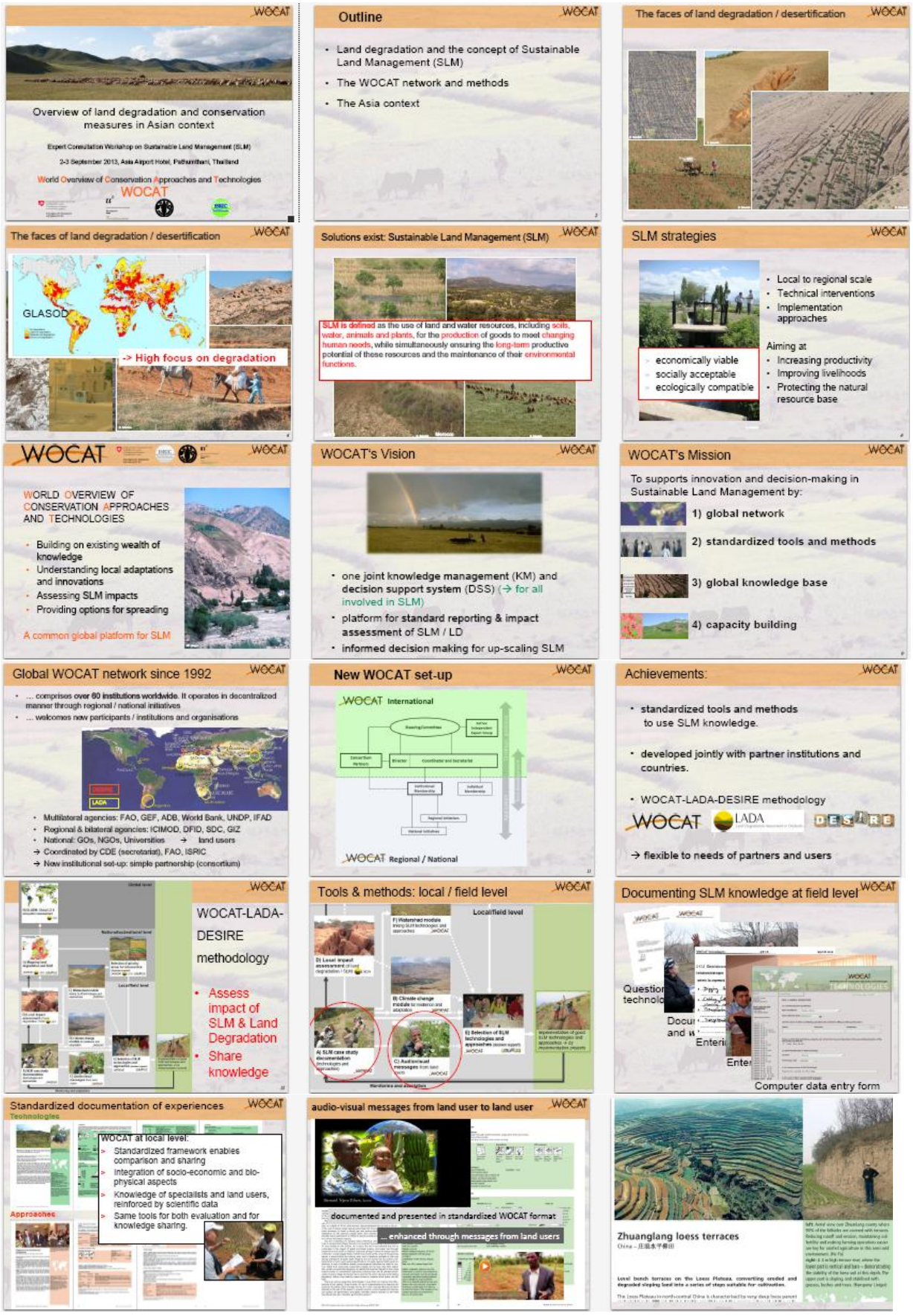
Ladies and gentlemen,

I wish to reiterate my gratitude to AIT and the ASOCON Coordination Unit for partnering with the FAO Regional Office for Asia and the Pacific to make this forum possible.

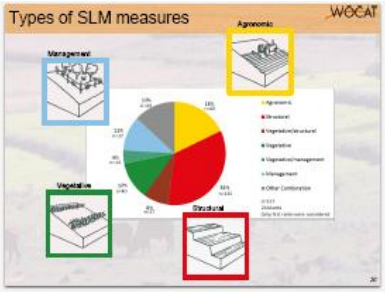
I wish you all a productive meeting.

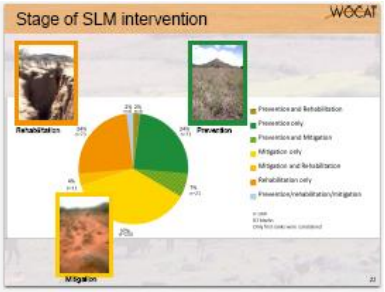
Thank you.

Appendix 4: Keynote Paper 1




Self-help groups
Kenya
Small-scale farmers forming self-help groups to provide mutual support for adopting and promoting conservation agriculture.

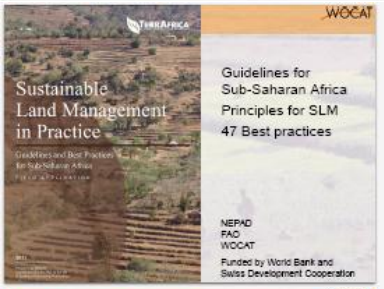

Types of SLM measures
WOCAT
Management
Agronomic
Vegetative
Structural


Stage of SLM intervention
WOCAT
Rehabilitation
Prevention
Mitigation

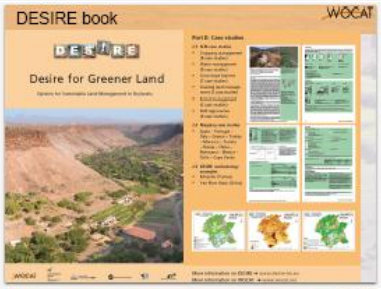

Global knowledge base
WOCAT
• 470 SLM technologies 230 approaches from 50 countries
• In Google Earth…
• Degradation and SLM maps from 20 countries
• Data search and query system … for analysis, reporting
All online, open source, in different languages

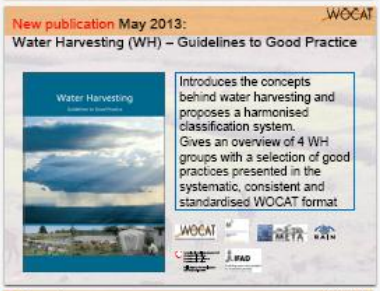

Synthesized experiences (global, regional national)
WOCAT
→ Inventories of practices and guidelines:
– Rainwater Harvesting (2013) - guidelines to good practice
– Desire for Greener Land (2012)
– SLM in Practice (2011): Guidelines for Sub-Saharan Africa
– Benefits
Good practices → principles, guidelines, policy points
– National (Ethiopia, China, Nepal, Bangladesh, Mongolia, Senegal, Tunisia, etc.)


where the land is greener
WOCAT
WOCAT Overview book: where the land is greener
Setting new standards:
• Global selection of case studies:
- 42 Technologies &
- 28 Approaches
• Standardized presentation
• Analysis
• Policy implications


WOCAT
Sustainable Land Management in Practice
Guidelines for Sub-Saharan Africa
Principles for SLM
47 Best practices
NEPAD
FAO
WOCAT
Funded by World Bank and Swiss Development Cooperation


Best Practices for Sub-Saharan Africa (Part 2)
Best practices – 13 groups
Integrated Soil Fertility Management
Conservation Agriculture
Rainwater Harvesting
Smallholder Irrigation Management
Cross-Slope Barriers
Agroforestry
Integrated Crop-Livestock Management
Pastoralism and Rangeland Management
Sustainable Planted Forest Management
Sustainable Forest Management in Drylands
Sustainable Rainforest Management
Trends and New Opportunities
SLM Approaches

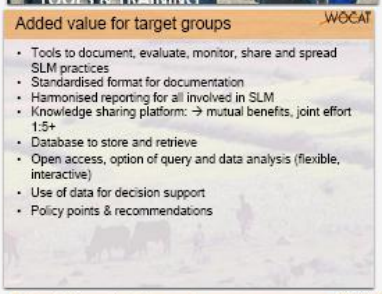

DESIRE book
WOCAT
DESIRE
Desire for Greener Land


New publication May 2013:
Water Harvesting (WH) – Guidelines to Good Practice
WOCAT
Water Harvesting
Introduces the concepts behind water harvesting and proposes a harmonised classification system.
Gives an overview of 4 WH groups with a selection of good practices presented in the systematic, consistent and standardised WOCAT format

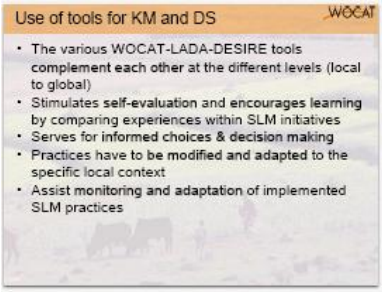

Training, education and research
WOCAT
• Training: over 500 SLM specialists from 40 countries trained in using WOCAT tools and running national initiatives (training of trainers)
• Linking development and research; evaluating SLM and filling knowledge gaps by applied research
• Support for monitoring and assessment of SLM impacts (on-/off-site; socio-economic and environmental)
TOOLS & TRAINING

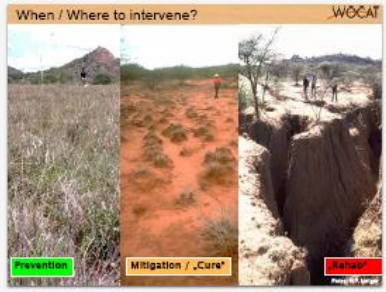

Main target groups
WOCAT
• SLM specialists at the field level, including technical staff, extension workers, agricultural advisors, project implementers
• SLM specialists at the (sub-)national level, including planners, project designers, decision makers, and researchers
• SLM specialists at the regional and global level, including international programme planners, and donors
• Ultimate target group & beneficiaries: land users and public benefitting from more secure environmental services


Target groups
WOCAT
→ A joint commitment at all levels & cross-sectorial


Added value for target groups
WOCAT
• Tools to document, evaluate, monitor, share and spread SLM practices
• Standardised format for documentation
• Harmonised reporting for all involved in SLM
• Knowledge sharing platform: → mutual benefits, joint effort 1:5+
• Database to store and retrieve
• Open access, option of query and data analysis (flexible, interactive)
• Use of data for decision support
• Policy points & recommendations


Link to UN Conventions
WOCAT
Strongest link to UNCCD, but also to other conventions
• integrated knowledge management system to increase accessibility to best practices
• SLM Best Practices reporting
• Scientific Knowledge Brokering Platform
– best practices for SLM standardised and harmonised knowledge management systems build a key pillar for informed SLM decision-making at different scales
– SLM practices are key for reducing vulnerability and creating resilience to drought and climate change while improving water and food security.

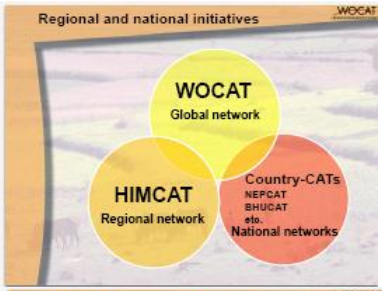

Use of tools for KM and DS
WOCAT
• The various WOCAT-LADA-DESIRE tools complement each other at the different levels (local to global)
• Stimulates self-evaluation and encourages learning by comparing experiences within SLM initiatives
• Serves for informed choices & decision making
• Practices have to be modified and adapted to the specific local context
• Assist monitoring and adaptation of implemented SLM practices

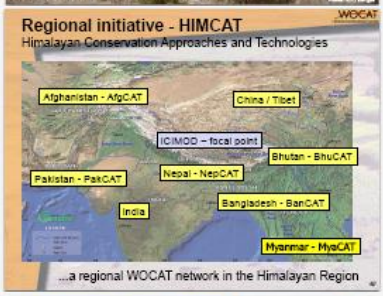

When / Where to intervene?
WOCAT
Prevention
Mitigation / „Cure"
„Rehab"


Scaling-up! Where?→ regional Decision Support
WOCAT
Starting degradation with strong degradation trend?
→ Prevention / Cure
What to spread? Where best?
Worst degradation?
→ Rehabilitation
What is the impact???


Which Technology / Approach? → local Decision Support
WOCAT
1 Approach: government SWC-Afforestation for Yellow river basin, supported by World Bank (PRC-GEF), ...
3
1
2
4
4 Technologies
Where? Costs? Impacts? Food security?
Combatting desertification, reducing floods/ DRR?
Adapted to climate change?

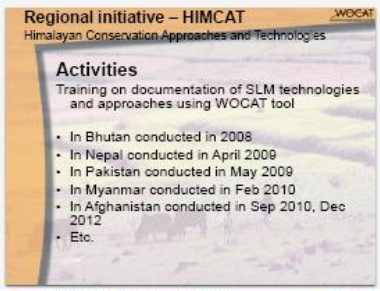

WOCAT
WOCAT network
• Asia-Pacific partnerships


Regional and national initiatives
WOCAT
Global network
HIMCAT
Regional network
Country-CATs
NEPCAT
BHUCAT
etc.
National networks


Regional initiative - HIMCAT
Himalayan Conservation Approaches and Technologies
Afghanistan - AfgCAT
China / Tibet
ICIMOD – focal point
Bhutan - BhuCAT
Pakistan - PakCAT
Nepal - NepCAT
Bangladesh - BanCAT
India
Myanmar - MyaCAT
...a regional WOCAT network in the Himalayan Region


Regional initiative - HIMCAT
Himalayan Conservation Approaches and Technologies
Objectives
Strengthening Cooperation, Collaboration, and Communication ..
.. among Himalayan SLM partners


Regional initiative – HIMCAT
Himalayan Conservation Approaches and Technologies
ICIMOD focal point:
Task:
• Support national initiatives
• Provide training
• Provide backstopping
• Provide linkages with global WOCAT
• Host HIMCAT website
• HIMCAT newsletter

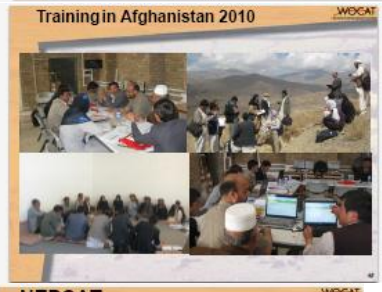

Regional initiative – HIMCAT
Himalayan Conservation Approaches and Technologies
Activities
Training on documentation of SLM technologies and approaches using WOCAT tool
• In Bhutan conducted in 2008
• In Nepal conducted in April 2009
• In Pakistan conducted in May 2009
• In Myanmar conducted in Feb 2010
• In Afghanistan conducted in Sep 2010, Dec 2012
• Etc.


Training in Bhutan 2008

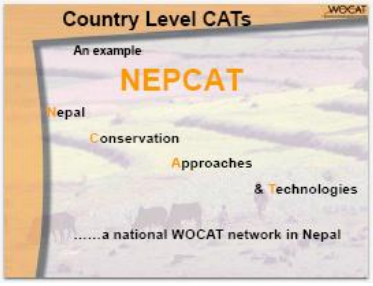

Training in Nepal 2009

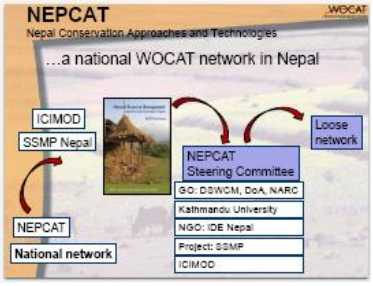

Training in Pakistan 2009

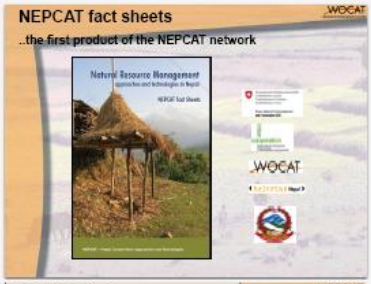

Training in Myanmar 2010

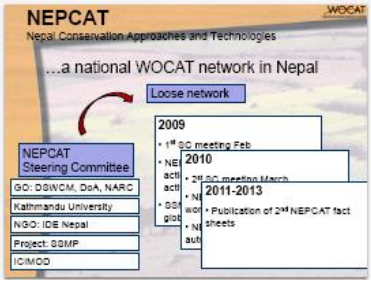

Training in Afghanistan 2010

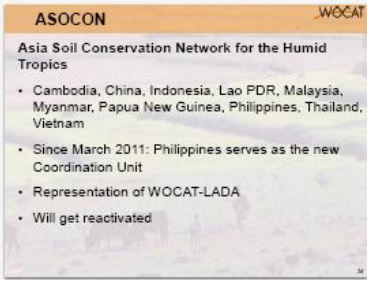

HIMCAT website
WOCAT
HIMCAT
Newsletter No. 5
December 2009
HIMCAT
Newsletter No. 6
July 2010
"Sustainable Land Management (SLM) Technologies and Approaches from the Mountain Region"
ICIMOD


Country Level CATs
An example
NEPCAT
Nepal
Conservation
Approaches
& Technologies
.....a national WOCAT network in Nepal


NEPCAT
Nepal Conservation Approaches and Technologies
...a national WOCAT network in Nepal
ICIMOD
SSMP Nepal
NEPCAT
National network
NEPCAT
Steering Committee
GO: DSWCM, DoA, NARC
Kathmandu University
NGO: IDE Nepal
Project: SSMP
ICIMOD
Loose network


NEPCAT fact sheets
..the first product of the NEPCAT network
Natural Resource Management
WOCAT


NEPCAT
Nepal Conservation Approaches and Technologies
…a national WOCAT network in Nepal
Loose network
NEPCAT Steering Committee
GO: DSWCM, DoA, NARC
Kathmandu University
NGO: ICIMOD Nepal
Project: SSMP
ICIMOD
2009
2010
2011-2013
• Publication of 2nd NEPCAT fact sheets


ASOCON
Asia Soil Conservation Network for the Humid Tropics
• Cambodia, China, Indonesia, Lao PDR, Malaysia, Myanmar, Papua New Guinea, Philippines, Thailand, Vietnam
• Since March 2011: Philippines serves as the new Coordination Unit
• Representation of WOCAT-LADA
• Will get reactivated


WOCAT website
www.wocat.net

Appendix 5: Keynote presentation – 2

SUSTAINABLE LAND MANAGEMENT

SOME EMERGING GOOD PRACTICES AND INSTITUTIONAL INNOVATIONS IN THE REGION

Eduardo Queblatin

1

THREE CONVENTIONS:

UNCCD- 10 year strategy

1. Improve living conditions of affected populations
2. Improve the conditions of affected ecosystems
3. Generate global benefits through effective implementation of UNCCD
4. Mobilize resources to support implementation through partnerships

CBD: 5 AICHI GOALS

1. Address underlying causes of BD loss
2. Address direct pressures on BD
3. Safeguard ecosystems, species and genetic BD
4. Enhance benefits to all
5. Participatory planning, knowledge management and capacity building

UNFCC- CANCUN ADAPTATION FRAMEWORK/ BALI ACTION PLAN)

1. Implementation- all parties to provide adaptation action
2. Support – from the developed countries
3. Institutions –different levels
4. Principles- country driven
5. Stakeholder engagement -

2

BASIS OF OBSERVATIONS

- 5 SLM Country Programs(Cambodia, Bhutan , Maldives, Samoa, Niue)
- 3 Country Efforts On CC Adaptation (2 Govt. projects and one NGO project in - Phil , Lao PDR , Myanmar)
- 2 Country Planning Efforts For Biodiversity (Lao PDR. Philippines)
- 7 Civil Society Programs On Community Forestry (5 ASEAN countries , Pakistan, Sri Lanka)

3

– EMERGING TRENDS
– RECOMMENDATIONS

4

A .EMERGING TRENDS AND INNOVATIONS

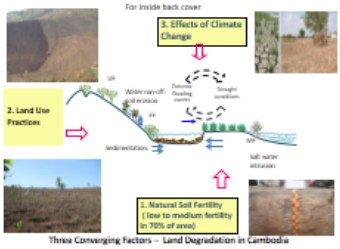
5

1.EMERGING MODERN DAY CHALLENGES THAT IMPACT/WILL IMPACT ON SLM EFFORTS

- BIOPHYSICAL –
  - Higher intensity of surface run off
  - Higher incidence of flash floods, mini- droughts
  - shorter fallows periods, high degradation
- SOCIO – ECONOMIC /POLITICAL
  - Aging Farmers, physical limits ...
  - Slow Pace Of Agrarian Reform
  - Rise Of Land Concessions with little regulation
  - Asean Economic Community(AEC)

6

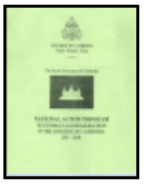
7



8

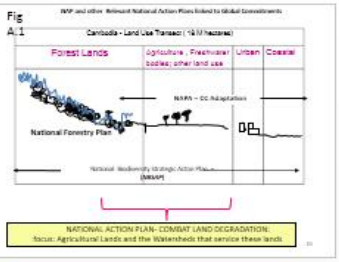
2. POLICY SITUATION

- SLM is low priority , compared to UNFCC & CBD
- Confusion on scope- of UNCCD
- Policy reforms in related sectors – IWRM, high value crops , organic agriculture

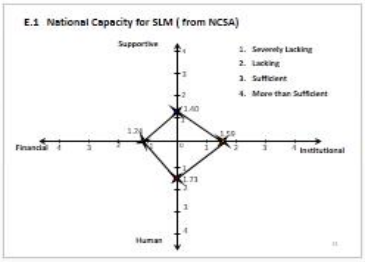


Example of a National Action Plan (NAP) to combat DLDD

9



10



11

12

13

4.COMMUNITY BASED SUSTAINABLE AGRICULTURE AND NRM – IS STILL THE FOUNDATION FOR CC ADAPTATION

New Technologies still being tested /fine – tuned locally:
•Timing of planting
•Drought resistant varieties

"Menu" of CC-Adaptation Strategies. (Lao PDR)

Local and locally tested Practices/technologies :
•Integrated farming systems
•Sustainable Agriculture
•Conservation Agriculture
•Community based Natural resources management (CB- NRM)
•NTFP

Mostly Sustainable Agriculture
-Can be disseminated immediately

14

Examples of notable interventions in the climate change era :

15

4.EMERGENCE OF LOCAL WATERSHED MOVEMENTS

- Documented By FAO'S *New Generation OF Watershed Mgt*
- Local & Multi Sectoral.
- "Light' organizations
- Complements The Basin Approach
- Major role for Local Authorities

16

17

18

6. STRONGER NEED FOR WORK ON AGROBIODIVERSITY BUT IT IS NOT CLEAR WHO IS RESPONSIBLE

Ministry of Environment ?

Ministry of Agriculture ?

19

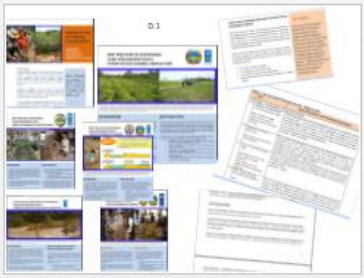
B. INITIAL RECOMMENDATIONS

20

1. UPDATING the NATIONAL ACTION PLANs (NAP)

- Go beyond the Ministry Of Agriculture, Go beyond soil science
- Inspire and engage other sectors - Identify and document Good Practices/local knowledge in SLM
- Consider also land governance issues
- Work with other sectors – eg. IWRM, Agrobiodiv, organic agriculture , land governance etc
- Think about financing at the start
- Highlight the role of local level

21



22

2.ADOPT THE LANDSCAPE (WATERSHED)APPROACH AND WORK MORE WITH LOCAL AUTHORITIES AS INTEGRATING PLATFORM FOR UNFCC, UNCCD AND CBD

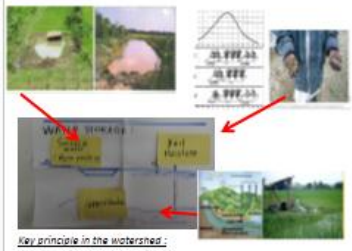
- Water as central issue in CC adaptation
- Think of Basin and watersheds (both are needed)
- New thinking on watersheds – not just about forests
- Go back to basics in water storage –
  - Surface water
  - Ground water
  - Soil moisture
- Work with IWRM advocates ,work with local authorities , other stakeholder groups (organic agriculture, agrobiodiv etc)

23

Landscape approach for SLM

24

25



Key principle in the watershed : Three ways to "store" water

26

New thinking on forests and watersheds

WM – RBM: provocative conclusions (I)

- Forests are crucial for watersheds but will not prevent large scale floods in the river basin
- WM needs to be embedded in RBM: WM plans (detailed) are components of RB plans (aggregated)
- Extrapolation / generalization from watersheds to river basins is dangerous

From : Hofer (FAO) , 2011 referring to the New Generation of Watershed Programs

27

1. Experience in Australia
(from Andrew Campbell)

28

Australia experience... Started with bottom up " landcare movements "

Many landcare groups now tired, like this sign

29

"Voluntary bottom up" (landcare groups ") ... Was gradually replaced by regional catchment organization .,..
has led to problems ....

Key Lesson ....need both bottom - up and top - bottom approaches

30

2.PHILIPPINE ACTION ON WATERSHEDS CURRENT TRACKS -

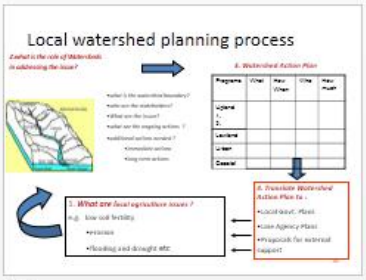
- NATIONAL GOVT - 18 major River Basins,
- NEW CONVERGENCE INTIATIVE (NCI) – 140 watersheds (3 national agencies on agriculture , agrarian reform and environment)
- LOCAL INITIATIVES ("MOVEMENTS ")- initiated mostly by local governments and civil society

31

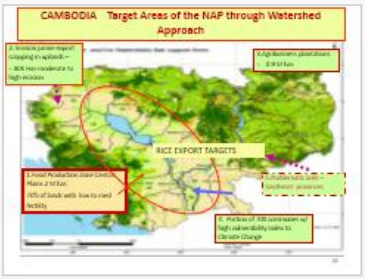
32

33

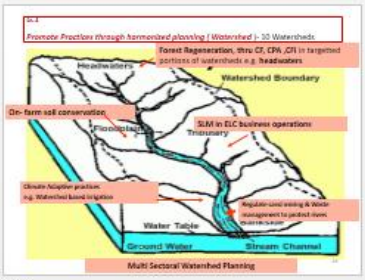
34



35



36



37

Community Based climate adaptation planning within micro- watersheds in Shan , Myanmar

38

3. ADDRESS AGRIBIODIVERSITY NEEDS

– In situ conservation – Globally Important Agricultural Heritage Systems (GIAHS)

– Indigenous community conserved areas (ICCA)

39

40

41

4. ADDRESS THE ROLE OF CORPORATE SECTOR IN LAND USE

E.G.

- Govt Private Sector Fora
- Start with the pioneering firms with strong CSR orientations

42

5. PLAN FOR INTEGRATED FINANCING AT THE START- EXAMPLES

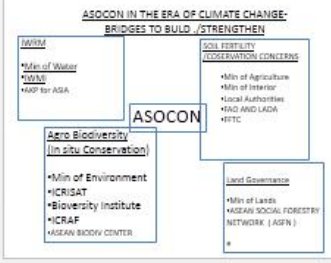
TYPE	SHORT TERM	LONG TERM
INTERNAL FINANCING		
•NATIONAL GOVT. BUDGET	X	X
•LOCAL AUTHORITY BUDGET	X	X
•FEES		X
EXTERNAL FINANANCING		
•OVERSEAS DEVPT ASSITANCE		X
•SMALL GRANTS FOR NGOS/LOCAL AUTHORITIES	X	
INNOVATIVE FINANCING		
•PAYMENT FOR ECOSYSTEMS SERVICES		X
•CORPORATE SOCIAL RESPOSIBILITY	X	
•VOLUNTEERISM	X	

43

SUMMARY

- Very complex needs of SLM in the 21st century-- can not be met by current sectoral approaches
- Broaden scope of concerns : link with movements in
  - IWRM (Min of Water, local water partnerships)
  - in situ- agro biodiversity (Min of Environment, civil society)
  - organic agriculture etc (Min of Agric, in of Trade OA movements
  - Land governance (Ministry of lands etc)
- Consider A POSSIBLE PLATFORM FOR 3 CONVENTIONS - - Landscape approach (combination of big basin and small watershed) through local initative (province /district)

44



45

Appendix 6: Contents outline for country paper preparation

I. Introduction/background - short introduction and objective of the paper
II. Situation analysis at country level
    a. Resource management sectors (agriculture, forest, grassland, etc.): *overview on historic trend (20 years of more) in each sector; country's mid- or long-term plan on each sector (for instance, attaining food sufficiency, increasing forest area in the country)*
    b. Major resource degradation problems: *major significant type of degradation problems along with their severity level; major causes of respective degradation problem (focusing on agricultural landscape)*
    c. Climate change and role of climate change: *climate change situation in the country; information needs for analyzing climate change impact on agriculture, forestry, etc.*
III. Barriers to adoption of soil and water conservation (SWC): *major barriers (technological, policy-related, social, economic/market, infrastructure, institutional, financial, etc.) preferably with respect to degradation problems.*
IV. Best/appropriate management practices – *major best management practices in the country in each sector for soil and water conservation (including in the context of climate change); extent of their adoption; Limitations/constraints, if any hindering the adoption of best management practices*
V. National action programs on soil and water conservation: *current and planned action programs; needed enabling environment for effective implementation of action programs in support of three Rio conventions*
VI. Conclusion/recommendations
VII. References
VIII. Annexes

Appendix 7: Country papers

Country Paper: Bhutan

Yeshey
Research Officer, Department of Agriculture, Ministry of Agriculture and Forest

1. Background

Located "on the roof of the world", the Kingdom of Bhutan is famous for its commitment to preserving its cultural and natural heritage and to pursuing Gross National Happiness (GNH), making this country rather unique in South Asia. However, Bhutan shares many features of rural development issues with its Himalayan neighbors. Bhutan, together with the rest of Asia and the Pacific is undergoing rapid natural resources bases, social and economic changes. These changes have important implications for land resources and consequently on long-term societal welfare. It is in this context, this paper is prepared based on various national documents. The paper aims to present the state of agriculture and forests resources management, agriculture resources degradation, climate variability issues, constraints to adoption of soil and water conservation, best management practices and the national action program for soil and water conservation.

2. Farming Environment and Population

Bhutan is a small, landlocked, mountainous Himalayan kingdom situated in the southern slope of the Eastern Himalayas, wedged between the two giants of China in the north and India to the east, south and west. The country has a geographical area of 38,394 square kilometers, and population of 7133,000 people. The terrain is among the most rugged and mountainous in the world. The topography varies from an elevation of about 100 meters above sea level in the south to more than 7,500 meters above sea level in the north (RGoB, 2008). Bhutan is divided into three geographic regions: eastern, central and western, with six, seven and seven administrative districts respectively in each region (Figure 1). The country can also be divided longitudinally into six major agro-climatic zones (Alpine, cool temperate, warm temperate, dry subtropical, humid subtropical and wet subtropical), with substantial variations in agro-ecological conditions and development features (Figure 2).

Environmentally sustainable development in Bhutan is closely linked with the development philosophy of GNH which recognizes environmental sustainability as one of the four main pillars for pursuing peace, prosperity and happiness. The Constitution of the Kingdom clearly outlines environmental conservation as a mandate (NAPCLD, 2009) which is also reinforced by a number of sector-based policies and laws. However because of the location, farming in Bhutan is challenging as the land holding size is small and the terrain is rugged with steep slopes making farm mechanization impossible and manual farming labour intensive. With economic development and urbanization, rural-urban migration has increased and farm labour shortage has emerged as a nationwide problem. As younger generation opting urban lives, most rural villages are homes to the ageing population (Tobgay, 2005). Consequently, some parts of Bhutan, agriculture is concentrated around the homestead and more remote

fields are kept fallow. Keeping land fallow is acceptable from a land management point of view because natural regeneration will ultimately protect the surface, but not acceptable from the agriculture development point of view in a country where 69% of the population depend on agriculture and where more than 50% of the country's grain requirement depend on import (MoAF, 2012).

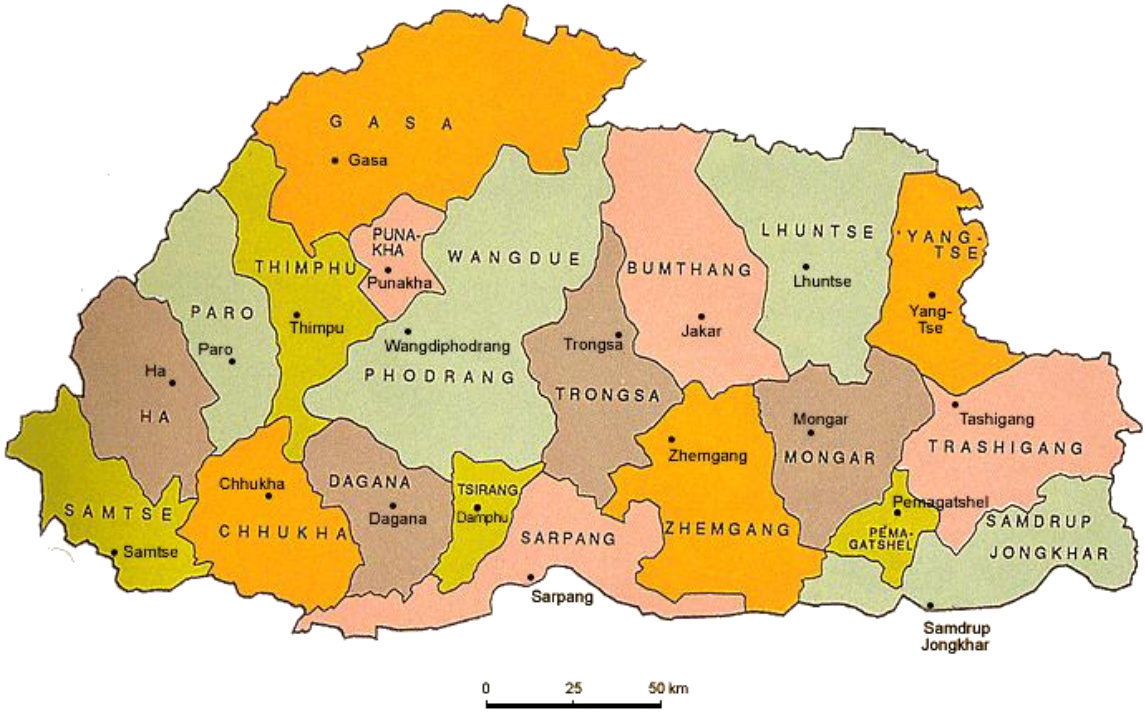


Figure 1: Administrative Map of Bhutan

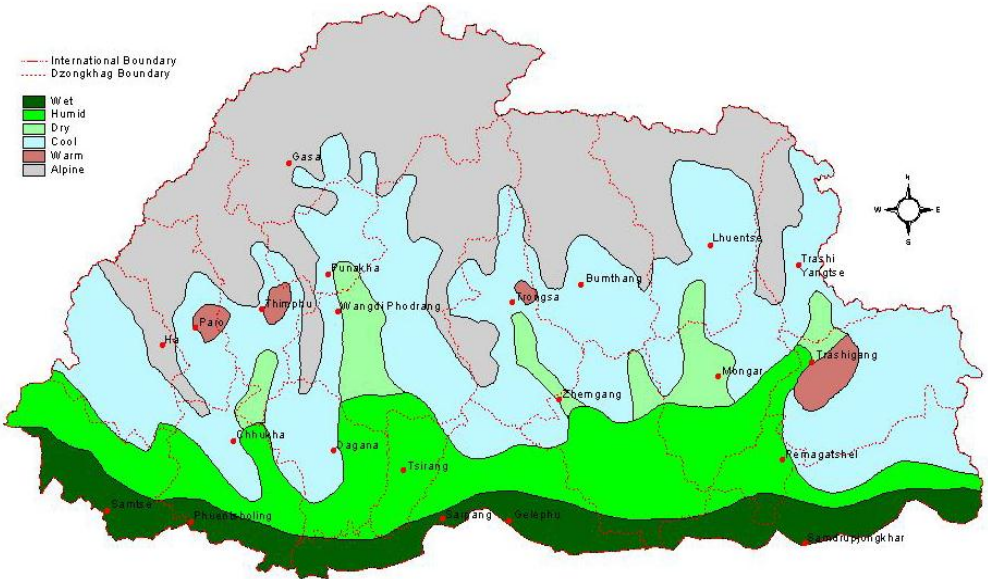


Figure 2: Agro-ecological Zones of Bhutan

The forest (tree) cover of the country is about 70.46%, arable land 2.93%, meadow land 4.10%, shrub land 10.43%, snow cover land 7.44% and bare areas 3.20% of the total

geographic area (LCMP, 2010). The country is rich in bio-diversity and water resources. The rivers and streams are being fed by the glacial lakes, glaciers, snowfalls and monsoon rains. Although there are numerous rivers and streams in the country, agriculture is still dominated by the dry land farming system that depends on the southwesterly monsoon rain that accounts to 60 to 90 % of annual precipitation. A wide range of agriculture and horticulture crops can grow year round in the agro-ecological zones from the wet-subtropical (150-600 masl) with a mean annual rainfall of 2500-5500 mm to temperate zones (2500-3500 masl) with mean annual rainfall of about 500 - 1,000 mm. The livelihood of 69 % of the population, mostly rural based is dependent on the agriculture sector, and this sector also provides employment to over 56 % of the total population. The overarching target of the 10th plan period (2008-2013) is to reduce the poverty from 23 % to 15 % at the end of 2013. The rural communities make up over 90% (GNHC, 2008) of this total poverty figure. The farmers living in remote and difficult terrains mostly remain disconnected from the main settlements during heavy monsoon rains in summer and snowfalls in winter. There were incidences of landslides, flash floods, and landslips that washed away cultivated land, disconnected food distribution system and distorted food prices in the local markets. The food security is at high risk under these geographical settings where settlements are scattered across very mountainous terrains.

2.1. State of current agriculture resources and management trend

The economy of Bhutan is predominantly subsistence and agrarian and is one of the smallest and least developed in the world. The amount of arable land amounts to 2.93% of the country's land area and comprises mainly small and often isolated pockets along the main river valleys or perched on flattened spurs and remnants of river terraces. Within the 2.93% of arable land, dry-land dominates with 61.90% followed by wet-land with 27.86%. The horticulture land constitutes of 10.24% i.e. Apple orchard (1.81%), Citrus orchard (4.52%), Areca nut plantation (0.88%), Cardamom Plantation (3.02%) and others (0.01%) (LCMP, 2010).

Table 1: Changes in the area under arable land over the period

Land cover assessments	Cultivated agriculture land (%)	Country area (Km^2)
LUPP (1995)	7.85	40077
PPD (2005)	4.85	38394
Cadastral Survey	4.47	38394
RNR Census 2000	2.64	38394
RNR Census 2010	2.32	38394
LCMP (2010)	2.93	38394

Source: LCMP 2010.

With diminishing arable land resource base and expanding population, meeting the food requirement has always been a challenge and the journey ahead is neither going to be any easier with climate change taking its toll. The prospects of sustainable agriculture in fragile areas are severely constrained by specific features of their natural resource endowments. Sustainability in a situation of low pressure on resources is possible through traditional land extension practices. But with the recent high pressure mainly from population growth and

economic development on fragile resources is not sustainable through traditional measures. It requires a balanced mixture of modern science and technology with indigenous practices. Progress in the suggested direction depends on the reorientation of agricultural strategies to suit the specific requirements of agriculture in Bhutan (CSP, 2007).

Thus, over the last many decades of planned agriculture development, the country went through substantial transformation. Starting from the first five year plan (1961-1965) period till the current tenth five year plan (2009-2013), Bhutan has achieved considerable progress in its socio-economic development (RGoB, 2011) . However, traditional farm practices are still prevalent in Bhutan despite government support and initiatives towards modern technologies and improved farming methods. Majority of Bhutanese population are still small and marginal farmers constrained with inadequate land holdings and remoteness. In addition to the subsistence nature of farming, scattered villages that are sparsely populated with limited accessibility characterize rural livelihood. The end of 2013 marks in Bhutanese history 52 years of planned economic development. The share of agriculture contribution to Gross Domestic Product (GDP) declined from roughly 55 percent in 1985 to 15.7 percent in 2012; however the Bhutanese economy is still governed by the agricultural sector as the main source of livelihood and income to the majority of the population (Tobgay, 2005). Bhutanese farmers subsists on farming by growing crops ranging from rice, wheat, maize, buckwheat, potatoes and barley depending on the climatic conditions. A sub-sector of the farmers dwells on animal husbandry by rearing cattle. The basic farming system that has evolved in Bhutan is essentially a mixed crop and livestock subsistence system, operated by small family units. Agricultural practices in Bhutan are labor intensive with relatively low intensity of farm inputs. A high proportion of family needs are met from consumption of farm produce and through bartering of goods and services within the local community. Most livestock and agricultural products are retained for local consumption, with very little made available for sale outside the local community.

2.1.1. Agriculture Development Planning

Planning in Bhutan is guided by the GNH philosophy and its four pillars of: i) Promotion of equitable and sustainable socioeconomic development, ii) Preservation and promotion of cultural values, iii) Conservation of the natural environment, and iv) Good governance. Accordingly, the priorities, strategies and programmes for the Five Year Plans (FYP) are formulated to ultimately contribute to GNH. GNH is the philosophy which guides the human and socio-economic development of the country and it places the individual at the centre of development and suggests a comprehensive and multi-dimensional approach to realizing and sustaining happiness. In addition GNH prescribes that equitable economic development can be attained and sustained through conservation of environment, preservation and promotion of culture, and enhancement of good governance.

During the previous FYP periods, the Royal Government of Bhutan (RGoB) has addressed a wide range of poverty issues broadly through its development targets, as reflected in the 9th FYP in Bhutan 2020 (RGoB, 2000). These targets closely match the Millennium Development Goals (MDG), and as such, stand as a testimony of Bhutan's strong national political commitment to socio-economic development and GNH which ensures that the Bhutanese

people not only have per capita consumptions above the poverty line but also enjoy better quality of life (DoP, 2005). Poverty and related issues are being addressed nationally and has been an important thematic subject at various national and international forums. The RGoB is also a party to a Poverty Reduction Partnership Agreement wherein the Government has committed itself to attainment of international development goals as enunciated in the World Summit for Social Development Declaration in 1995. However, the Poverty Analysis Report (PAR 2004), and other previous poverty studies, suggested that despite good governance and a remarkable progress in the economic development of the country, poverty is still a reality in contemporary Bhutan. RGoB also recognizes that much still needs to be done as poverty still persists. Furthermore, the changing scenario in international development assistance has also compelled and RGoB to make sure that its development focus is geared more toward assisting vulnerable groups.

In addition Bhutan as a member of global community, the country is also party to international conventions. Being so, the country has to fulfill the obligations related to global and regional Conventions. In particular, Bhutan has embraced international benchmarks for improving the quality of life by committing to attain the Millennium Development Goals (MDG). To fulfill the MDGs, the Renewable Natural Resources (RNR) sector has to contribute to halving extreme poverty and hunger of the 2000 level by 2015, promoting gender equality, and ensuring environmental sustainability. Similarly, the SAARC development goals require RNR sector to eradicate hunger poverty; halve proportion of people living under the poverty; ensure absolute reduction in the number of poor within the same period; ensure nutrition and dietary improvement for the poor; ensure a robust pro-poor growth process by mandatory budget allocation targeted to rural and informal economy sectors; strengthening connectivity of poorer regions and of poor as a social group; ensure effective participation of the poor and of women in anti-poverty policies and programs; maintain acceptable level of forest cover; maintain acceptable level of water and soil quality; ensure adequate conservation of biodiversity; and ensure wetland conservation in the region in accordance with the RAMSAR Convention (BCS, 2011).

Development planning for agriculture in Bhutan therefore has undergone crop, livestock and forest production. The integrated nature of the farming systems at the local level led the government to adopt an integrated approach for planning and implementation of the programmes. The RNR sector launched a programme framework approach, which was a major shift from Agriculture Development Projects and zoning. The programme framework was designed to enable the formulation and implementation of an integrated developmental approach to crops, livestock and forest systems as the primary basis policy for the organization of support services. Thus, it was the first bold step by the Ministry of Agriculture then to prepare an integrated sector plan (RGoB, 2002). This has helped to rationalized resource allocation and to make the programmes more environmental friendly and sustainable. The Plan also addressed some key integrative aspects of sectoral development, such as land-use planning, resource and environmental conservation, research and extension, sustainability, marketing and human resources development, as they have a cross-cutting effect on the subsectors.

At the farm-level in order to increase farm production through diversification, the agricultural sector has propagated and disseminated many varieties of high yielding cereals

as well as horticultural crops and vegetables to farmers while rendering technical services through its extension services. New crops included different types of potatoes which are being produced all over the country and exported to India and Bangladesh, different varieties of apples, and new varieties of rice and maize. Many types of vegetables that were not grown or marketed some 25 years ago are now available and people consume them regular as part of their normal diet. Efforts were also made in the field of soil fertility management and water resources conservation.

2.2.1. An overview of forestry resources management

Since Bhutan is a latecomer to the development process, its natural resource base is largely intact. It is the policy of the government to ensure that the rich endowment of the country is preserved and that development remains sustainable. Thus, fortunately for Bhutan, environmental planning precedes environmental degradation; the principle of sustainability integrated in all government policies.

Bhutan has maintained a good forest cover of 70.46% of the total land area and is the dominant land cover (LCMP, 2010). This has been the result of conservation centered policies and relatively low population in the past. As part of strong national focus on natural resource conservation, Bhutan is committed to maintain a minimum of 60% forest cover for all times to come, as is reflected in the forest legislation and also in the Constitution (MoA, 1995). The enormous variations in soil, temperature, altitude and rainfall have created highly diverse forest vegetation that contains almost all of the major forest types. The three main types of forest in Bhutan are subtropical, temperate and alpine. Under subtropical, there are three subtypes such as subtropical broadleaved hill forest, subtropical pine forest and subtropical dry evergreen forest. Similarly the three subtypes under temperate forest include mountain wet temperate forest; Himalayan moist temperate forest and Himalayan dry temperate forest. The structure and composition of these forests differ considerably and so does their economic and ecological significance (SASRR, 2012). The forests of Bhutan are highly diverse in terms of forest types and species composition. Major eco-floristic zones are well represented over a small area due to geographical diversity combined with equally diverse climatic conditions and bio-geographic history. LCMP, 2010 divided forests into two sub-classes which are then further classified into six categories while LUPP, 1995 indentified nine broad forest types in Bhutan. Similarly Atlas, 1997 divided Bhutanese's forest into different types (LUPP, 1994). However, the officially accepted forest types are based on LCMP, 2010 which has seven forest types as provided in Table 2.

With its sound and strong environmental policies in place, Bhutan has always emphasized on sustainable management of natural resources. With consistent enforcement of laws and policies followed by public education, the Department of Forests and Park Services (DoFPS) had by and large succeeded in increasing the national forest coverage and institutionalizing the process of sustained supply of forest resources (Dhital, 2005). However, with current pace of urbanization, population growth and increasing developmental activities, the DoFPS is faced with many challenges that put at risk the very principles of sustainability of forest resources. The Department is vested with the responsibility of both protecting the natural resources as well as meeting people's basic needs.

Table 2: Forest types in Bhutan

Forest Types	Total area (km^2)	Area %	Total area %	Forest cover (%)
Fir Forest	1832.08	4.77	70.46	80.89
Mixed Conifer Forest	6139.64	15.99		
Blue Pine Forest	800.24	2.08		
Chir Pine Forest	1076.67	2.80		
Broadleaf Forest	16889.56	43.99		
Broadleaf and Conifer Forest	314.72	0.82		
Shrubs	4005.26	10.43	10.43	

Source: LCMP, 2010

Forest Management in Bhutan has passed through three major phases:

1. Traditional and customary management system before the planned economic development started in 1961.
2. Nationalization of forests in 1969 and diminution of customary rights – open access.
3. Gradual transition to current system of sustainable and participatory forest management.

Forest Management in Bhutan has three major management regimes:

1. Protected Area Management (Parks, Wildlife Sanctuaries and Biological Corridors) covering 51.44% of the total forest cover.
2. Community Forest Management (Social Forestry) covering 2.10% of the total forest cover in Bhutan.
3. Forest Management Units under scientific management systems, covering 5.40% of the total forest cover in Bhutan.

Rest of the country's forest which covers about 21.95% is lying idle without any management prescription. Most of the rural timbers for house construction, fire wood, flag poles, fencing posts were supplied from this chunk of forests. Of course some timber requirements are also supplied from Forest Management Units (FMU) and Community Forests (CF), but timber supplied from FMUs are based on scientific calculation of the Annual Allowable Cut (AAC) and Annual Harvesting Limits (AHL) from the CFs.

Increasing forest area will be huge challenge due to population growth, urbanization, resettlement, road constructions, forest fire and other infrastructure developmental activities. In addition, most of the resettlement programs and land substitutions were made from government forests thereby significantly decreasing the forest area. However, by Constitutional provision in Article 5(3), we are require to maintain 60% forest cover in all times to come. To meet the constitutional requirement, the mid-term plans to increase forest cover are mainly through plantation (Afforestation and reforestation programs). The long terms plans to increase forest cover is through strategies that includes education and advocating of the general public and policy makers on forest conservation and its

importance (MoA, 2000). The program also includes community forestry, social forestry and urban forestry.

2.2.2. Afforestation/Reforestation

Reforestation of degraded and barren forest land has been a longstanding program of the DoFPS. In fact, the first forest plantation was carried out way back in 1947 even before the Department of Forests was created. Since then, the total plantation area as of 30th June 2012 is 23,700.448 ha (59,251.12 acres). Different agencies under the MoAF such as District Forestry Sector and Territorial Forest Division were establishing numerous plantations. Other agencies who establish plantations are Natural Resources Development Corporation Limited (NRDCL) and Bhutan Board Products Limited.

2.2.3. Community Forestry

Community forestry program was introduced in the country in the 1990s. The Community Forestry (CF) is relatively recent policy instrument in Bhutan to involve people actively in sustainable management of forests resources and at the same time, contribute to their livelihoods. Since decentralization of forestry activities in the 1990s, CF is expected to be seen as a practical expression of decentralization and an approach for improving the governance of natural resource at the local level. One of the underlying faiths of CF is that forest resources will be managed sustainably and human well-being will be enhanced, and in the long term, it is expected to contribute to the philosophy of GNH. The primary objective is to promote, establishment and management of forests through community participation in a way that there is improvement in local forest conditions and at the same time greater socio-economic benefits to the local communities in terms of increased availability of timber, fuel-wood, fodder and Non-Wood Forest Products (NWFP). However, it took several years to operationalize CF programme on the ground due to absence of appropriate legal framework and lack of capacity in terms of trained personnel and extension guidelines. The first CF was established in 1997 and as of June 30th 2013, there are 526 CF established all over Bhutan. The total number of households registered as Community Forest Management Group (CFMG) is 22, 985 which accounts to 35% of the total rural households in Bhutan. The area covered by 526 CF is 59,404.69 hectares which comes to 2.10% of the total forest cover in Bhutan (LCMP, 2010).

2.2.4. Sustainable Forest Management

The Royal Government Bhutan continues to take numerous initiatives towards ensuring both conservation and sustainable utilization of forest resources. The commitment to achieving environmentally sound, socially acceptable and economically viable forest management is the driving force behind development of first Forest Management Code of Bhutan in 2004. The dynamic Code provides a comprehensive set of guidelines for sustainable planning and implementation of such plans in government forests especially in FMUs. In order to cater to the demand for wood without degrading forest resources and diminishing future forest productivity, the DoFPS has been planning and implementing forest harvesting operations based on the principles of sustainability. All forest areas identified for harvesting is

inventoried to determine growing stock, demand-supply situation and identify ecological protection needs. Based on the inventory, management plans are prepared for harvesting of these areas. Forest areas with management plans are called Forest Management Units (FMU). Each FMU required operating within the limits of annual allowable cut and without weakening the ecological functions of the forest area. At present, there are a total of 17 FMUs and Working Schemes in operation. These FMUs and Working Schemes cover altogether 5.4% of the total forest area in Bhutan.

2.2.5. Shifting Cultivation

The practice of *Tsheri* (shifting cultivation) or many called it "Slash and Burn Agriculture" has been banned by the Royal Government in mid 1990s. As per the Land Act, 2007 *Tsheri* is not considered as any land category registered in the name of a person and therefore, the practice was discouraged. *Tseri* cultivation is also banned with strong opposition from the DoFPS due to its numerous negative impacts to the environment. The ban of *Tseri* also contributed in increasing forest cover, although at very minimal percentage.

2.2.6. Environment Friendly Road Construction

Considering the geologically fragile and rugged mountain terrain of the country, the Department of Roads (DoR) has adopted Environment Friendly Road Construction (EFRC) as a key program strategy for sustainable development of roads. To enable the implementation of EFRC, the DoR has prepared comprehensive environmental codes of practice for road construction. Since the commencement of the ongoing 9th FYP, all road construction activities were required to adopt environmentally sound techniques and conform to the environmental codes of practice. The Environment Assessments Act, 2000 and its regulations also required all kinds of roads to adopt environmentally friendly road construction techniques. However, implementation of the same has not been satisfactory due to budgetary constraints, lack of technical capacity among the contractors and the motive among some to maximize profits. The capacity for the DoR for technical backstopping and compliance monitoring of EFRC standards and norms is also deficient at the moment.

2.3. An overview of the Rangeland (Grassland) Resources

In Bhutan rangeland refers to native grassland stretched from sub-tropical to the alpine zone of the country. The sub-tropical and temperate rangeland fall within an altitude range of 1500-3000 m asl. Similarly the alpine and sub-alpine rangelands fall within the altitude range of 3000 – 5000 m asl. These areas include the entire northern belt of the country and comprise 3.9% of the total land use in the country (Chophel, 2009). The rangelands of Bhutan therefore comprise alpine grasslands, temperate shrub-lands and sub-tropical forests. Each of these categories contains within them a wide diversity of livestock ranging from water buffaloes in the southern foothills to yaks in the alpine meadows. Several species of cattle, sheep and equine are distributed throughout the different agro-ecological zones.

Rangeland in Bhutan falls under communal state and are governed by forestry rules and regulations. Herders have only grazing rights over the rangelands and are restricted to undertake any development activities. Rangeland is registered in the name of individuals, communities and institutions. The government levied an annual fee based on the area registered. There are traditional arrangements on the use and management of rangeland resources. Each village or cluster of villages has an institutional body for managing pastures, primarily consisting of experienced herders of the village. Such an institutional body makes various decisions based on consensus. Decisions made by the institutional body usually relate to grazing schedules to regulate the movement of livestock to and from the village; distribution of pastures to different households; grazing fees to be charged to other villages that wish to use the pasture resources of the village; and penalties on those who violate the mutual agreement (Gyamtsho, 1992). The district wise registered rangeland distribution is presented in table 3.

Table 3: District wise rangeland distribution in Bhutan

District name	Rangeland (ha)	District name	Rangeland (ha)
Tsirang	662.00	Punakha	17569.00
Pemagatshel	3162.00	Gasa	13893.00
Samdrup Jongkhar	8764.00	Zhemgang	18775.00
Sarpang	365.00	Samtse	15775.00
Tashi Yangtsi	1665.00	Haa	60778.00
Mongar	7142.00	Bumthang	26671.00
Dagana	9235.00	Chukha	21014.00
Lhuentse	9108.00	Wangdue	50719.00
Trongsa	21687.00	Thimphu	77317.00
Paro	1767.00	Trashigang	40445.00
TOTAL			**406,513**

Source: RNR Statistics, 2007

2.3.1 Importance of rangeland

Rangeland, apart from providing forage for livestock, they are the sources of many major rivers that are harnessed for hydropower generation. They also serve as critical habitats for numerous endangered plant and wildlife species of global importance. Besides, they are becoming increasingly popular as recreational sites for tourists and have potential to improve economies of pastoral communities. The ability of the rangelands to meet the traditional and new demands depends on the way it is managed (Gyamtsho, 1992). Further, livestock grazing enables pastoralists to convert otherwise unusable plant biomass into valuable animal products, as cultivation is difficult on these rangelands (Chophel, 2009).

Rangelands are the main sources of livelihood for the alpine herders and it is needless to mention the vital role it plays in the economy of the herding communities. Rangeland had sustained the livelihood of herding communities for centuries and will continue to do so in the future. Despite the harsh environment, herders over centuries have meticulously adjusted themselves within the fragile ecosystem and emerged as a strong determinant of the future of rangeland.

However rangeland health is a concern as unforeseen consequences associated with the negligence of rangeland will result in loss of highlanders' culture and livelihood. Visual observation may indicate rangelands to be in their natural state but investigation reveals that the improper management over centuries has deteriorated rangelands (Chophel, 2009). The glaring evidence is that the climax grass species, which once thrived in open meadows, are now found only in inaccessible and undisturbed areas due to decades of unregulated grazing and without sound management interventions. Various unwanted shrubs and trees have invaded the large open meadows (Gyamtsho, 1992).

2.3.2. Rangeland Research and Development

Improvement and sustainable utilization of rangeland have been with the policy makers and development program implementers since 1969 when the Forest Act nationalized all the forest resources under state property. Numerous attempts were made to design and implement strategies and programs for the benefit of the herding communities, natural environment and national economy. Rangeland research and development under livestock sector faced major setback in the ninth 9th FYP due to lack of priority in feed and fodder and use and management of native grasslands (*Tsamdrog*). Further, the goals and objectives of the 9th FYP were to develop infrastructure, strengthen farm business and develop markets for livestock products. The plan does not clearly reflect rangeland as a priority area for livestock development and thus, there was lack of strong vision and strategies to bring about desirable changes in the rangeland and livelihoods of the herding communities. Therefore, rangeland research and development efforts were weak in the 9th FYP. However in the 10th FYP, the priority given to rangeland research is relatively better as compared to the 9th FYP. The plan places emphasis on longer-term research on rangeland and native grasslands, which are the main sources of livelihood for the high altitude herders. The research is also focusing on collection, characterization and identification of plant communities, which in the end is expected to lead to identification of potential native fodder species for inclusion in the native grassland and rangeland improvement programs. Unlike in the 9th FYP, feed and fodder researchers are evaluating different management regimes to renovate the already degraded rangeland in the 10th FYP. Multidisciplinary approach is being adopted to create collective responsibility and accountability amongst the stakeholders. The rangeland research and development received more attention in the 10th plan period. However, it is to be noted that the existing system is facing severe shortage of man power trained in rangeland science. In the tenth plan, the focus of rangelands and native grasslands research is on two broad areas. The first priority area of rangeland research is to understand, evaluate and document existing grazing management practices by herders and propose an appropriate grazing management practices for resource sustainability. The other priority area is to scale up prescribed burning research across the country aimed at improving composition and diversity of grass meadows. Rangeland research will also initiate activities on the possible effects of land use and vegetation cover on the riverine systems (Chophel, 2009).

2.3. Major land resources degradation problems

Bhutan lies in the foothills of the Eastern Himalayas with most of its mountain ranges running from north to south. Because of its topography and altitude, Bhutan has inherently limited resources of productive land. Moreover, the predominantly steep slopes make land degradation an even more serious threat in Bhutan than in most places (Norbu *et al*., 2000). Land degradation thus is becoming an important issue in Bhutan because of its adverse impact on agronomic productivity, the environment, and consequently on food security and the quality of life. In Bhutan land degradation processes are interactive, sequential and cumulative. For instance, quite small depletions of some nutrients lead to a decrease in soil organic matter. This in turn weakens the physical structure of the topsoil, making it easier for rainfall and surface runoff to remove it. In this way a relatively minor change in soil chemistry leads to erosion. Similarly, minor forms of erosion intensify rapidly, and small rills grow to large gullies. These processes are common in Bhutan and slowly lead to the formation of huge gullies, landslides and ravines.

2.3.1. The key causes of land degradation in Bhutan

Because of the fragile mountainous landscape, land degradation is emerging as a key environmental issue in the country despite environmental conservation occupying a pivotal place in the national development policies and programs. Various forms of soil degradation are manifesting themselves all over the country largely owing to natural calamities and anthropogenic factors.

Forest fires - Forest fires persist as a recurrent and widespread phenomenon in the country. According to records maintained by the Department of Forests, 643 incidents of forest fires affecting a total forest area of 83,759 hectares have taken place between 1998/99-2007/08. Almost all of the forest fires in the country are caused by humans accidentally or willfully.

Excessive use of forest resources - Bhutan's per capita fuelwood consumption is one of the highest in the world. In rural areas, fuel-wood is the main source of energy for cooking and space heating. According to the Department of Energy, in 2005, fuelwood alone accounted for 57.7 percent of the total primary energy supply. Apart from domestic use in rural areas, fuelwood is heavily used for industrial production, agro- and forest products processing, road construction, and in hospitals, schools, military encampments, and monasteries. Construction timber use is also very high with traditional architecture entailing extensive use of timber

Overgrazing - Livestock rearing is an important economic activity among the rural communities and overgrazing is closely associated with forest degradation as much of the grazing occurs in forest lands on a free-range basis. Rural communities keep large livestock herds because of religious sentiments against culling, status symbol associated with large herds, the perception of livestock as an immediate source of cash in the event of emergency, and for production of farmyard manure.

Unsustainable agricultural practices - Unsustainable agriculture practices exist in the form of imbalanced and prolonged use of inorganic fertilizers, farming of lands on steep terrain without adequate soil and water conservation measures and limited use of balanced soil

inputs. Poor management of irrigation system is also a major concern. Construction of earthen irrigation channels in places where the soil is highly erodible, poor maintenance of irrigation systems, and lack of management of the tail sections of irrigation channels have weakened adjoining lands and caused downward movement in many places, especially where cultivation lands are on hill slopes.

Construction of infrastructure without proper environmental measures - Construction of roads in the country is enormously environmentally challenging given the mountainous terrain and fragile geologic conditions. Use of heavy machinery and cutting of mountain slopes to build roads without proper environmental safeguards and mitigation measures inevitably cause problems such as slope failure, deforestation, disturbance to wildlife habitats, and sedimentation of water bodies.

Mining- Mining has become one of the fastest growing economic sectors in the country. The most significant adverse impacts of mining are land disturbance and fissure from drilling, blasting, excavation, and site clearing, destruction of natural vegetation, sedimentation and contamination of waters, and air pollution with dust particles affecting human health and local livelihoods such as agriculture production

Industrial development - Many industries depend on extraction of raw materials, such as wood and minerals, from the natural environment. The volume of extraction and the technology used for extraction of these natural resources have considerable bearing on the environmental quality of the lands from where they are extracted. Other major industrial activities that contribute to land degradation include dumping of industrial waste, discharge of harmful effluents, and conversion of forest and agricultural lands for development of industrial estates.

2.3.2. Common land degradation types on the agricultural landscape

There are many powerful natural processes such as river down-cutting, underground piping, water saturation, etc. that are working vigorously. Much of the landscape is only quasi–stable, and needs only a small trigger to destabilize it and for its surface materials to slip down slope and eventually be washed downstream. The present situation as per the estimates made by the (UNEP, 2001), approximately 40,000 ha or 10% of the total agriculture land is affected by various forms of degradation, out of which water erosion is the main threat followed by chemical and biological soil degradation.

By applying the GLASOD definitions of degrees of degradation (Table 4 below) the estimation on the degree to which the land is presently degraded in Bhutan is presented (Table 5).

Table 4: GLASOD definition of degree of land degradation

Degree	Definitions
Light	The terrain has somewhat reduced agricultural suitability, but is suitable for use in local farming systems. Restoration to full productivity is possible by modifications of the management system. Original biotic functions are still largely intact.
Moderate	The terrain has greatly reduced agricultural suitability, but is still suitable for use in local farming systems. Major improvements are required to restore productivity. Original biotic functions are still partially intact.
Strong	The terrain is non reclaimable at farm level. Major engineering works are required for terrain restoration. Original biotic functions are largely destroyed.
Extreme	The terrain is non-reclaimable and beyond restoration. Original biotic functions are fully destroyed

Table 5: Common land degradation types and their severity

Types	Causes	Degree of degradation	Occurrence
Splash erosion	➢ Heavy rainfall on bare soil exposed by clearing	Light	➢ Extensive ➢ Mostly in dry-land
Sheet erosion	➢ Steep slope ➢ Heavy rain on bare soil ➢ Deforestation ➢ Overgrazing	Moderate	➢ Extensive ➢ Mostly in dry-land on clay-rich soils in Eastern Bhutan
Rill erosion	➢ Heavy rain on loose, bare topsoil ➢ Leaking irrigation channels ➢ Livestock trails ➢ Unchecked sheet and splash erosion ➢ Poor ground cover ➢ Overgrazing ➢ Deforestation	Moderate	➢ Extensive ➢ In dry-land, when pre-monsoon rains are heavy
Piping erosion	➢ Water logging and subsoil compaction ➢ Leaking irrigation channels ➢ Over-irrigation	Moderate	➢ Localized in all types of land
Gully erosion	➢ Unchecked rill erosion ➢ Logging and stock trails ➢ Steep slopes ➢ Deforestation ➢ Overgrazing ➢ High rainfall	Moderate	➢ Extensive ➢ In unstable geology (E.g. phyllite and on unstable soils e.e. deep red clays)

	➢ Poor drainage system		
Landslides	➢ Free faces, e.g. road cuttings and gully sides ➢ Over irrigation and other water logging activities ➢ Deforestation ➢ Unstable soil and unstable underlying geology	Strong	➢ Extensive ➢ In unstable geology in the south and eastern parts of the country
Ravine formation	➢ Unchecked gullies and landslides ➢ Unstable soil and underlying geology ➢ Inappropriate land management practices ➢ Deforestation ➢ Overgrazing	Extreme	➢ Localized, especially in the East
Flooding	➢ High and intensive rainfall ➢ Accentuated by upstream land clearance and erosion	Strong	Mostly concentrated in wide valleys where much cultivation occurs.

Source: Land Degradation in Bhutan: An Overview, 2004

2.3.3. In-situ Chemical and Physical land degradation

Other types of land degradation include in-situ physical and chemical degradation. The most widespread in-situ chemical degradations are soil organic matter and nutrient depletion. Limited application of organic fertilizers, conversion of forest and grass land into arable land, leaching of nutrients and top soil erosion are the main causes of the in-situ chemical degradation. While they occur extensively both in dry-land and in wet-land, their processes and effects are less spectacular than erosion, and are not always easy to identify. However, they are the most extensive kinds of arable land degradation. Their effects in reducing agricultural production have not been quantified, but are almost certainly substantial. The underlying cause is the shortage of farm labour. While the traditional soil fertility management systems based on the use of animal manures still dominate, the ability to maintain and sustain these indigenous systems is being undermined by two factors such as socio-economic development and farm labour shortage. (Baillie *et al*, 2004).

Similarly the two most common types of *in-situ* physical land degradation are topsoil capping and subsoil compaction. While topsoil capping occurs mostly in wet land, subsoil compaction takes place extensively both in wet land and also in orchards. Insufficient organic fertilizer application, bare soil expose to heavy rain, animal trampling and repeated ploughing to the same depth are the causes. In-situ physical degradations are not highly visible and tend to be unobserved. However, they are noticed by farmers when ploughing

and digging. They are widespread and reduce the productivity more than is realized and both tend to make soils more liable to erosion. Other unnoticed but relatively extensive erosions are wind erosion and cultivation erosion. Wind erosion is extensive especially when there is no cover crop and soil is exposed. Although it is difficult to quantify, the erosion is assessed as being quite substantial and contributing to lowering the soil fertility by removing the fertile topsoil (SFU, 2005). Cultivation erosion occurs mainly because of the rugged terrain, where most of the arable lands are located on steep slopes (up to 70% slope). During cultivation on such fields, the topsoil of the upper part of the field is moved down slope during every tillage operation. As a result, the whole topsoil of the field move down slope exposing the subsoil on the upper part of the field. The topsoil accumulates at the lower part of the field and if proper soil conservation measures are not taken, the lower parts become susceptible to slumping. This type of erosion is very extensive.

2.4. Climate change and role of climate change

Bhutanese farming system has evolved over a long period of time characterized by diversity of ecological condition. The variability over time and heterogeneity over space has led to the development of unique and diverse agriculture systems specific to different locations. While these diverse farming systems contributed within their own capacities as adaptation mechanisms to different climatic and bio-physical conditions, majority of the farming communities in Bhutan still constantly face with food shortages and thus depend heavily on imported food. Limited land holding, expansion of population, land degradation and climatic variability affecting agricultural production are the main underlying causes. With climate variability which is mostly evidenced by extreme drought and erratic rainfall patterns, the challenge is huge for buffering the agricultural systems against climatic variation and attaining food security. Bhutan is already exposed to natural and climate related disaster such as drought, strong wind, late and early rainfall patterns, temperature variations, hailstorm, flooding and earthquake in recent times. These events have affected agricultural activities at larger extend and also human health, livestock and the overall ecosystem.

2.4.1. Local Symptoms of Warming

The impact of climate change assessed by the Intergovernmental Panel on Climate Change (IPCC, 2007) reported that in the region crop yield will decrease that will put many millions of Asians at risk from hunger. Water stress will affect more than 100 million people and land degradation may increase due to decrease in soil moisture. Changes in mean rainfall and temperature as well as increase in extreme events will affect agriculture, livestock, fishery and forestry. In Bhutan, there are cases of loss of crops to unusual outbreaks of pest and diseases, erratic rainfalls, windstorms, droughts and flash floods/landslides are increasing annually. During the rice blast epidemic in 1996, the high altitude farmers lost 80 to 90 % of their rice harvest. The maize harvest loss by the farmers above 1800 masl during outbreak of northern corn blight disease was more than 50% of their production in 2007. The crop harvest of about 320 households was also affected in 2008 by severe windstorm. Many believe that these are local symptoms or impacts of global warming.

(NAPA, 2012) report has summed up the consequences of heavy monsoon rains on the fragile mountain ecosystems of Bhutan. The glacial lake over flow in 1994 affected 96 households, 816 acres of dry land, 965 acres of pasture land, 16 yaks and 16 tons of food grains was washed away. There are 2,674 glacial lakes out of which 24 lakes are potentially regarded as dangerous. The southern belts received one the heaviest rainfall in the summer of 2000 where in 24 hours, Phunstholing recorded 449 mm, Tala recorded 500 mm and Gedu recorded 520mm. Thimphu, the capital city remained cut off for almost a month from Phuntsholing where food supplies come on daily basis. The eastern region of the country was severely affected by flash floods and landslides from heavy rainfall in 2004. The losses included 9 lives, 162 houses and 39 irrigation channels were damaged and 22 bridges washed away. The total arable land affected were 161 acres of wetland, 503 acres of dry land, and in terms of food items, 350 mt of maize, 126 mt of paddy, and 2000 citrus trees were damaged. Transportation remained disrupted for many days in most of the eastern and southern dzongkhags during that period. When land holding is small and crop yields are low, these seasonal damages on livelihood properties have significant impact on the local food security and well being. The country is therefore seriously concerned of the current issues and possible threats posed by climate change/global warming on the agriculture production, environment, biodiversity, human lives, livelihoods and the sustainable socio-economic development in the country.

2.4.2. Climate Change Knowledge Sharing

Science has firmly established that the earth is warming rapidly, and is caused by the green house gases (GHG) emitted mostly by the anthropogenic activities. Contribution of GHG from farming includes release of the carbon dioxide through burning, nitrogenous oxides from poor management of chemical fertilizers and methane emission from rice cultivation, maintaining large size of cattle, and conversion of marshy/wet lands. The contribution of these gases from Bhutanese farming system is small and indeed, these releases could be easily off set by good vegetation cover around the local environment. The research technologies and extension messages in the farming sector passed onto farming communities do not capture processes of GHG release, and its impact on local, regional and global atmosphere. Engagement of local growers, professionals, and politicians in debates and discussions of the impact of climate change on food security is important to define future course of action. The question is how well are they informed on these events and developments in the climate change debate taking place every year around the globe.

The farming communities have been experiencing the impacts of frequent erratic weather patterns on their livelihood assets and food security almost every year. The farmers living in the remote areas are the most affected section of the society. How to prepare and adjust the farming systems in accordance with the changing local weather pattern is important to reduce risk of losing livelihood assets and fear of food insecurity. For example, the local annual plans or five year plan do not capture the elements of adaptation and mitigation actions in the agriculture sector because either the policy guidelines are not clear on these issues or that the local institutes have no idea on how to approach these threats.

One way to reflect these deficiencies in the regional, national and local plans is through strong advocacy, education and creation of awareness at all levels on likely impacts of climate change on food security. The best way to begin is by documenting the erratic weather events that lead to losses of livelihood assets and farm produce. Collection and analysis of time series local climate data could help to educate and inform decision makers and planners to seek policy and financial support. This information is also essential to contribute to national and regional information centre to help in predicting changes affected by global warming. These actions would help to mainstream impacts of climate change on food security into local and national debates, plans and programs.

3. Barriers to adoption of soil and water conservation

Soil and Water Conservation technology fits well in a mixed farming environment of Bhutan to reduce soil erosion, improve soil fertility and moisture, and increase crop diversity and fodder availability. This technology is one of the best options for many environmental problems caused by anthropogenic activities in Bhutan. The farmers, however, do not pick up this technology easily mainly because of the following reasons:

3.1. Socio-economic barriers

Low awareness among farmers – Although land degradation through soil erosion is one of the main constraints to crop production, this problem receives the least attention from the farming communities. This is mainly because of the subsistence nature of farming; farmers give more importance to their immediate needs than to the long term benefits. Consequently, investments in the implementation of soil and water conservation measures are usually not on the list of the farmers' priorities. This attitude can be explained by more-pressing crop constraints (such as damage by wild animals and agricultural pests), the increase in off-farm income and remittances, and the high future expectations of cash-crops. This explains that farmer often do not invest in combating land degradation (Turkelboom & Wangchuk, 2009).

Limited land holding and type of farming systems practiced - The average farmland holding size is around 4.3 acres. This limited land holding has been fragmenting because of family division. The other obstacle is, most of the farmers let their cattle loose after the harvest of crops. This poses a problem in maintaining hedgerows in the winter season.

Farm labour shortage – The vast majority of Bhutanese live rugged lives of isolation and the life are hard and conditions are harsh. As a result, rural-urban migration is on the increasing trend. School drop-outs and younger generation do not want to stay on farm; instead they opt for off-farm activities. This leaves the rural villages as home for only the older generation.

3.2. Institutional and financial barriers

Limited human and institutional capacities – There is only one National Soil Service Centre and four Regional Research Centers and these centers are not well equipped both in terms

of trained staff and facilities. Of the four researches centers, some do not have a focal person for soil and land management research and development work. Similarly, resources unavailability is another constraint for promotion of soil and water conservation measures.

Lack of information – Even though land degradation is a major problem in the country there is a lack of information. There are no reliable, comprehensive and up to date information on the causes, extent, and trend of land degradation. Similarly there is no documentation of the economic and social implication of land degradation in the country.

3.3. Policy and Institutional barriers

Lack of National Land Use and Management Policy- At the macro-level and as a cross-sectoral issue, a well-defined policy perspective on national land use and management is presently lacking. Land degradation impacts several sectors and land use conflicts between various sectors have become frequent. Urban expansion has led to loss of prime agricultural lands and depletion of forests, road construction in geologically fragile areas has caused and exacerbated landslides, agriculture on steep terrain have led to soil erosion, several mining operations have reportedly caused health and environmental hazards. Furthermore, programs and activities to address land degradation have remained compartmentalized within various sectors. Green sectors such as agriculture and forestry feature SLM more prominently in their policies and programs whereas brown sectors, especially those concerning infrastructure and urban development, have only cursory or no reference to SLM in their policy and programmatic frameworks. This suggests the tendency to relate SLM closely as an environmental issue rather than a development issue.

Weak Enforcement of Environmental Laws and Regulations- Bhutan has very strong laws and regulations for the conservation of environment and mitigation of adverse environmental impacts from development plans, programs and projects. The Environment Assessment Act 2000, Forest and Nature Conservation Act 1995, Mines and Mineral Management Act 1995, and the National Environmental Protection Act 2007 are some of the key laws that provide immense scope for pursuing environmentally sustainable development and pre-empting environmental degradation at a far-reaching scale. However, our environmental laws and regulations have not been effectively implemented. Dearth of law enforcement personnel, ambiguity in institutional mechanisms, and lack of technical and financial resources to implement environment-friendly technology are some of the key reasons for weak law enforcement

Institutional Lacuna for National Land Use and Management - At present, there is a lacuna in the institutional setting for overall technical coordination of national land use and management policies, plans and programs. There are two relevant non-ministerial, inter-agency bodies that can potentially function as the overall technical agency for national land use and management. One is the National Environmental Commission (NEC), but it currently does neither have the institutional structure nor the professional capacity to deal with land use and management effectively. The other is the National Land Commission (NLC) but its current mandate and institutional structure is restricted to the administration of the Land Act of Bhutan 2007 and has very little to do with the technical aspects of land

use and management. The current institutional scenario is that the NSSC under MoAF is the main implementing agency for the Sustainable Land Management Project, the largest project specifically dedicated to combating land degradation. However, the institutional makeup of NSSC as a soil management referral and research facility within the MoAF is such that it can have only limited influence on other agencies, especially those outside the MoAF. This lessens its efficacy to oversee and coordinate sustainable land management in a cross-sectoral manner (LCMP, 2010).

3.4. Technological Barriers

Soil and water conservation technologies on sloping land reduced the cultivable area by about 20%. In addition live barriers compete for nutrients affecting food crop production. There are also cases that farmers abandoned live barriers because of their interference with tillage operations. Implementation of soil and water conservation measures demands high labour input which most resource poor farmers cannot afford. Resource poor farmers often invest their labour in off-farm activities for cash income generation.

Limited implementation period- Most soil and water conservation measures such as bio-hedgerows or live barriers need to be implemented in a certain period, which coincide with the peak farming season. Consequently, implementations of soil and water conservation measures get the least importance and implementation of the same often get delayed or in most cases never happens.

4. Best Management Practices

4.1. Water Conservation

Unlike in other sectors, there is not much change in the conservation and management of water resources. Nevertheless, Royal Government of Bhutan enacted the Water Act of Bhutan, 2011 in recognition of water as one of the most important natural resources of the Kingdom. Acknowledging water resource as a State property and the State's rights over mineral resources, rivers, lakes and forests are enshrined in the Constitution of the Kingdom of Bhutan; Recognizing the seasonal and local scarcity of water for drinking and agricultural purposes, despite the country being endowed with abundant water resources; Being mindful that rapid socio-economic development results in increasing pressure on the environment including water resources; Recognizing the threat from climate change in addition to increasing anthropogenic threats on water resources and watershed conservation even with the existing policy of sustainable management of natural resources; Being determined to protect the environment and human health through integrated water resources management in pursuit of Gross National Happiness and the age old tradition of living in harmony with nature; Bearing in mind that every Bhutanese have assured access to adequate, safe and affordable water to enhance the quality of lives; And realizing the need for a comprehensive legislation, which shall also foster institutional linkages to guide various water user sectors in the best interest of the nation and the people.

From the institutional side, the best management practices include the renovation of the existing infrastructures, improving the conveyance capacity of the traditional irrigation

systems, construction of new irrigations channels wherever possible and required. Catchment protection through plantation and rainwater harvesting are other practices. Drip irrigation and sprinkle irrigation systems are tried on trial basis in apple and citrus orchards. However, because of the affordability issue, these technologies have not picked up well by the farmers. In rice cultivation, intermittent irrigation practice have been tried and proved successful with not much affect on the yield when compared to conventional practice (DoE, 2000). However its adoption rate is relatively low as most farmers believed that more water means more yield when it comes to rice cultivation.

At the farmers' level the best management practices include the use of traditional water sharing system to address the water shortage and equity issue and formation of water user associations.

4.2. Soil Conservation

In the field of soil conservation, from the institutional side the best management practices include:

- ✓ Dry-land terracing
- ✓ Wet land terracing
- ✓ Grass hedgerows
- ✓ Legume fodder hedgerows
- ✓ Contour stone bunds
- ✓ Agro-forestry
- ✓ Orchard establishment

While there is a list of BMPs, quantification of area coverage under each of these BMPs has not been done. In most places, BMPs are introduced and promoted through project supported programs. Initially, because of farm household labour shortage, the adoption of BMPs has been low; however institutionalization of farmer groups for sustainable land management has helped the farmers to ease their acute labour shortage through labour sharing. This has helped many households in the implementation of BMPs. Most resource poor farmers, who are concerned with soil erosion problems and aware of measures to adopt, are not always able to do so, because of limited resources. Such situation needs to be overcome through alternative approaches and extra efforts such as institutionalization of farmer groups. Any future sustainable land management initiative should aim at enabling rural communities to adopt land management approaches conducive to increase farmer participation and adoption of the technologies to enhance land conservation (DoA, 2005). Good planning is the best tool in the implementation of the best management practices.

5. National Action Program on Soil and Water Conservation

The national action program for soil and water conservation draws its fundamental essence from the country's overarching development philosophy of GNH. The program aims to contribute to the objective of environmental sustainability whilst also directly or indirectly contributing to poverty alleviation, food security, economic growth, and human safety. Prevention and mitigation of land degradation and its impacts through systems and practices

of sustainable land management that protects and maintains the economic, ecological and aesthetic values of our landscapes is the overall goal of the program.

5.1.1. Improvement of Sustainable Agricultural Practices

Integrated Soil Fertility Management - development of training and extension materials; training of trainers for extension staff; farmer training; dissemination of the advantages of integrated soil fertility management and the disadvantages of disproportionate and prolonged use of inorganic fertilizers through television and radio; comparative studies on various soil fertility management techniques and practices and improvement of soil fertility management techniques and practices based on the results; and establishment of soil testing labs at the regional level to provide more expeditious information on soil quality and guidance for soil improvement to extension staff and farmers.

Sustainable Land Management for Steep Slope Agriculture - land capability studies to develop agricultural land capability classification and formulate management guidelines for agricultural land use as per land capability; promotion of low-cost Sustainable Land Management (SLM) technology for steep slope agriculture; promotion of SLM-based farm enterprises linking SLM with poverty alleviation/ income generation; and mainstreaming SLM in research programs and translation of SLM research results and recommendations into farmer-friendly extension materials.

Improvement of Irrigation System Management - review and revision of existing irrigation development guidelines to integrate management of the tertiary irrigation channels and tail sections of the irrigation channels; rejuvenation of dysfunctional Waters Users Associations (WUA) through training, extension and financial support; training of district engineers to provide irrigation-related services and backstopping to WUA; and rectification of irrigation schemes that pose significant land degradation risks.

5.1.2. Conservation, Rehabilitation and Sustainable Use of Forest Resources

Forest Fire Management - assessment of the occurrence, trends and causes of forest fires; in-depth research on forest fire ecology in various forest ecosystems; development of forest fire management strategies for various fire-vulnerable forest ecosystems; public education and awareness programs; community-based forest fire management schemes targeting specific groups of local communities; rationalization of forest fire penalties; and review and strengthening of institutional arrangements for networking, reporting and forest fire suppression.

Sustainable Production and Utilization of Forest Resources - development of technical capacity to effectively implement the planning guidelines for management of forest areas outside the FMU system; implementation of planning guidelines on a pilot basis and evaluation of the applicability and effectiveness of the guidelines; and multi-disciplinary evaluation of the effectiveness of FMUs throughout the country in the context of environmental sustainability and socio-economic development to enhance the planning and management of FMUs.

Rehabilitation of Degraded and Barren Forest Lands - assessment of the extent of degraded and barren forest lands, mapping and prioritization of these areas for re-afforestation; establishment of a fully-functional system for developing plans for the establishment and long-term management of forest plantations; and leasing of degraded/ barren forest lands to private parties for plantation and commercial forestry.

Participatory Forest Management - participatory training to develop community skills for community and private forestry; training of district and block forestry staff in communications and extension approaches and techniques; integration of sustainable use of various types of NWFPs in community forestry schemes; and development and promotion of agro-forestry models as part of the private forestry program.

Livestock and Grazing Management - livestock carrying capacity studies and development of a taxation scheme to discourage the rearing of livestock in excess of the carrying capacity; provision of effective animal health coverage; establishment of farmer cooperatives to oversee proper utilization of forage resources; development of hay meadows with high-yielding fodder legumes and grasses; promotion of homestead forests of species with high forage value; promotion of alternative livelihoods where livestock rearing has become unsustainable; and lease of barren/ degraded government lands to local communities for pasture development.

5.1.3. Environmental Management of Development Activities that pose High Risks of Land Degradation

Environment-friendly Road Construction - mandatory adoption of environmental codes of practices in road construction projects; expeditious adoption of the draft farm road development guidelines; training of road engineers, private road contractors and contract engineers in EFRC approach and techniques based on existing ECOP and (approved) farm road development guidelines; cost-benefit analysis between roads built with EFRC techniques and traditional techniques to aid decision-making; rationalization of existing farm road targets vis a vis existing technical and financial capacity for EFRC; provision of adequate road survey equipment to district engineering sectors for proper road planning and alignment; and integration of EFRC as a module in diploma/ degree engineering courses provided within country.

Sustainable Mining - review of existing institutional mechanisms for the implementation of mining law and regulations, and strengthening them to enhance law enforcement; training support to private mining companies to develop their technical capacity for environmental management of mining operations and restoration of mined areas; development of environmental codes of practices for mining activities and making its application mandatory; ensuring all mining companies have submitted environmental management plan and mine restoration plan as per acceptable standard; capacity development of the Department of Geology and Mines and collaborating agencies for monitoring, inspection, regulation and technical backstopping of environmental management activities of mining operations; and cost-benefit analysis of various mining operations in the geologically fragile southern foothills.

Sustainable Urban Development - promotion of regionally-balanced urban development; improvement of municipal governance and strengthening municipal capacity to effectively manage urban environments; integrated rural-urban planning to address rural-urban migration and bring about balanced development of rural and urban areas; ecological mapping and zoning of all major urban centers and their peripheries and protection/ rehabilitation of ecologically vulnerable areas.

Solid Waste Management - introduction of a system for waste segregation at source and adoption of proper landfill management practices; establishment of waste recycling hubs in major towns; creation of appropriate implementation mechanisms for the recently enacted Waste Prevention and Management Act 2009; and public awareness campaigns to change public attitude and inculcate healthy habits for proper waste care and disposal.

5.1.4. Strengthening of Systemic and Institutional Capacity

Policy and Legislation Development - development of a National Land Use and Management Policy; formulation of a National Mining and Mineral Development Policy laying out Bhutan's fundamental position and principles for mining; finalization and ratification of the long due Grazing Management Policy and Act.

Strengthening Enforcement of Environmental Laws and Regulations - assessment of the institutional capacity and identification of capacity needs for the enforcement of various environmental laws and regulations, and strengthening institutional capacities based on the assessment; strict enforcement of the full range of procedures and processes for environmental assessment and clearance on projects which inherently have very high potential of adverse environmental impacts; development of the technical capacity of District Environment Officers and other members of DEC to implement environmental Assessment (EA) process; development of the technical capacity of Competent Authorities within the line Ministries to implement EA process; development of National Environment Commission's (NEC) capacity to carry out compliance monitoring of EA Act and Regulations and provide technical backstopping to the Competent Authorities and DECs; and creation of public awareness of environmental laws and regulations, including their rights and responsibilities, to foster active public participation and support to law enforcement.

Institutional Development - creation of a cross-sectoral agency, within National Land Commission (NLC) or NEC, for overall technical coordination of national land use and management; strengthening the institutional capacity of the Department of Disaster Management and District Administrations to effectively deal with natural disasters; and establishment of a central weather organization supported by regional real-time weather stations for weather monitoring and forecasting.

5.1.5. Information, Advocacy and Education for Policy and Public Support

These include a country-wide quantitative survey of land degradation to assess the nature, extent and scale of land degradation and generate quantitative information to primarily inform decision-making, provide baseline for monitoring land degradation trends, support

awareness raising programs, and aid planning of geographically-targeted actions to combat land degradation. Another significant information development activity would be to create a national website dedicated to land degradation issues, through which information views and solutions on land degradation can be exchanged. This website could also contain a "Bhutan-Land Degradation Information System", which could be developed using the data accrued from the land degradation survey. Development and use of Bhutan Environment Outlook/ State of the Environment Reports for advocacy and public education, and production of a TV documentary series highlighting land degradation trends and issues have also been recommended.

6. Conclusion and Recommendation

Currently, most of the environmental problems in the country are localized and generally associated with high population density, urbanization and industrialization. There are few environmental problems which are more extensive in terms of geographic spread, e.g. forest fire, soil erosion by water and overgrazing. And then there is the climate change due to air pollution and global warming, which have to be essentially addressed through global cooperation.

Bhutan has continued to make headways in the field of environmental conservation. Since the State of Environment 2001, the country has taken significant steps. These includes the incorporation of environmental conservation as a key article in the draft Constitution of the Kingdom, accession to several multi-lateral environmental agreements, strengthening of legislation and regulatory framework, development of environmental codes of practices, standards, norms and devolution of environmental governance.

But, at the same time, significant gaps still remain. Policy implementation has not been able to keep pace with policy formulation. Enforcement of environmental standards and norms is weak due to financial and human resource constraints and weak inter-agency coordination. Some important polices and legislations, for instance pertaining to pollution and solid waste management are lacking. Dearth of information and data persists, making assessment of environmental conditions and trends difficult. Finally, lack of sustainable financing mechanism for brown sector-based environmental management remains a critical gap.

Recommendations

6.1. Development and Promotion of Sustainable Agriculture Practices

6.1.1. Integrated Soil Fertility Management

- ✓ Develop toolkits for training of farmers on integrated soil fertility management. The toolkits may include training handbook (for the agriculture extension staff), posters, flipchart, video, pictorial manual and other materials that may be necessary for farmer-friendly training. And training of agriculture extension staff in use of farmer training toolkit.

- ✓ Conduct farmer training on integrated soil fertility management in a phased manner, first focusing on districts where use of inorganic fertilizers is most excessive.

- ✓ Disseminate through television and radio the advantages of integrated soil fertility management and the disadvantages of disproportionate and prolonged use of inorganic fertilizers.

- ✓ Carry out comparative studies on various soil fertility management techniques and practices, both indigenous and introduced, and based on the results improve soil fertility management techniques and practices.

- ✓ Establish soil testing labs within Regional Research Centers to provide more expeditious information on soil quality and guidance for soil improvement to extension staff and farmers. This is being recommended because currently there is only one soil testing lab, located at NSSC Semtokha, and this inadvertently leads to inconveniences and longer duration in delivery of soil samples and test results.

- ✓ Develop and promote cropping systems and practices that help soil nutrient management.

6.1.2. Sustainable Land Management for Steep Slope Agriculture

- ✓ Conduct and complete land capability studies. Based on these studies, develop agricultural land capability classification and formulate management guidelines for agricultural land use as per land capability.

- ✓ Develop and promote low-cost SLM technology for steep slope agriculture. An option would be to examine existing external SLM technology, such as Sloping Agriculture Land Technology (SALT) and adapt it to Bhutanese conditions. Such technology must be backed up by development of farmer-friendly training and extension materials followed by training of farmers in a phased manner.

- ✓ Develop and promote SLM-based farm enterprises, linking SLM with poverty alleviation/ income generation, and thus making SLM more attractive for farmers.

- ✓ Mainstream SLM in Renewable Natural Resources Research (RNRR) programs and translate SLM research results and recommendations into farmer-friendly extension materials.

6.1.3. Improvement of Irrigation System Management

- ✓ Review and revise existing irrigation development guidelines, especially examining ways in which management of the tertiary irrigation channels and tail sections of the irrigation channels can be improved.

- ✓ Review the functionality of Water User Associations (WUA) and invigorate dysfunctional WUAs with community training, extension services and financial support.

- ✓ Train district engineers to provide irrigation-related services and backstopping to WUAs using irrigation development guidelines as the basis.

- ✓ Rectify existing irrigation schemes that have become highly risky from the land degradation point of view.

6.2. Conservation, Rehabilitation and Sustainable Use of Forest Resources

6.2.1. Forest Fire Management

- ✓ Fully assess the occurrence, trends and causes of forest fires. Concurrently, carry out a nation-wide public attitude and behavior survey to assess public perception and outlook towards forest fire and its impacts.

- ✓ Carry out in-depth research on forest fire ecology in various forest ecosystems. Such research would need to take into account the results of prescribed burning trials carried out in in the country.

- ✓ Develop and implement public education and awareness programs using innovative avenues such as rural theatre, folk music, school cultural events, religious festivals, and painting/ quiz/ debate competitions. It is desirable that the awareness programs are developed based on public perception and outlook towards forest fire and its impacts assessed through public attitude and behavior survey.

- ✓ Develop and implement community-based forest fire management schemes targeting specific groups of local communities, such as lemon grass oil producers and graziers.

- ✓ Review and rationalize existing forest fire penalties to make them enforceable. Review and strengthen institutional arrangements for networking, reporting and forest fire suppression. Institutional strengthening would among other things include procurement and management of forest firefighting equipment such as helmets, fire-proof gear, fire fighting tools, walkie-talkie, first-aid kit, and binoculars. It would also entail identification of focal persons in various agencies for mobilization of fire fighters and strengthening a network of community fire watchers and volunteers for expeditious reporting and suppression of forest fires.

6.2.2. Sustainable Production and Utilization of Forest Resources

- ✓ Develop the capacity of the territorial forestry divisions to effectively implement the planning guidelines for management of forest areas outside the Forest Management Unit (FMU) system for sustainable production and utilization of forest resources. Capacity development would include staff training backed up with necessary computers, customized software and field instruments required for implementation of the planning guidelines.

- ✓ Implement the planning guidelines in at least one forest area in each territorial forestry division and evaluate the applicability and effectiveness of the guidelines in these forest areas. The results of the evaluation will be used for improving the planning guidelines for more widespread use.

- ✓ Carry out a detailed evaluation of the effectiveness of FMUs throughout the country in the context of environmental sustainability and socio-economic development, and use the results of the evaluation in enhancing the planning and management of FMUs.

- ✓ Develop and promote alternative fuels and construction materials to reduce dependence on forest resources. For instance, the NRDCL has introduced production and sale of sawdust briquettes in Thimphu in the recent years. This initiative could be scaled-up to other districts such as Bumthang, Haa and Paro where there is a huge demand for fuelwood especially during winters.

6.2.3. Rehabilitation of Degraded and Barren Forest Lands

- ✓ Assess the extent of degraded and barren forest lands, map these areas, and prioritize them for re-afforestation taking into consideration a number of factors such as socio-economic benefits to the local communities, ecological risks (both immediate and long-term) of not rehabilitating the forest land, and contribution to global environmental needs such as carbon sequestration and adaptation to climate change.

- ✓ Re-afforest prioritized degraded and barren forest lands using species and methods that are environmentally appropriate to local conditions.

- ✓ Lease out degraded and barren forest lands to private parties for plantation and commercial forestry based on a public-private partnership model through which Department of Forests (DoF) provides technical support and guidance to ensure that such enterprises are economically beneficial as well as ecologically sound.

- ✓ Establish a fully-functional system for developing plans for the establishment and long-term management of forest plantations. Such plans would need to include detailed activities related to site survey, species selection, planting methods, thinning, weeding, pruning, harvesting, fire management, and control of pests and diseases.

6.2.4. Participatory Forest Management

- ✓ Design and impart participatory training to develop community skills for community and private forestry focusing on activities such as community organization, conflict resolution, benefit-sharing and community fund management. This is recommended because community forestry has evolved into a major program since the first community forest was established in 1997. As of April 2009, there were 131 community forests covering about 16,380 hectares of forest land. By the end of the Tenth FYP, the DoF has planned to establish a total of 400 community forests covering at least four percent of forest land. For the sustainability of the fast-spreading community forestry program, it is very crucial to equip the local communities with adequate technical and social skills to establish and manage community forests.

- ✓ Train district and block forestry staff in communications and extension approaches and techniques to effectively provide guidance and technical backstopping to community forest user groups and private forest owners.

- ✓ Integrate sustainable use of various types of non-wood forest products, based on community priorities, in the community forestry schemes. Such schemes will also need to include strategies for marketing Non-Wood Forest Products (NWFP).

- ✓ Develop and promote agro-forestry models as part of the private forestry program with special attention to soil and water conservation, and maintenance of soil fertility.

6.2.5. Livestock and Grazing Management

- ✓ Carry out carrying capacity studies and based on these, develop a taxation scheme to discourage the rearing of livestock in excess of the carrying capacity.

- ✓ Provide effective animal health coverage to give livestock farmers the security to keep smaller but more productive herds of livestock.

- ✓ Establish farmer cooperatives that will among other things oversee proper utilization of forage resources through monitoring of stock numbers, grazing pattern, nutrient management, and control of weeds.

- ✓ Develop hay meadows with high-yielding fodder legumes and grasses under high nutrient supply conditions to reduce grazing pressure on forests.

- ✓ Promote homestead forests of species with high forage and soil conservation values.

- ✓ Where overgrazing is a problem but livestock rearing is the primary source of livelihood, develop and promote improved pasture management and forage development. Concurrently, promote alternative livelihoods that are environmentally sustainable.

- ✓ Identify barren/degraded government lands that can be potentially leased for pasture management as per the provision of the Land Act of Bhutan 2007. Prepare and implement pasture management plans for the leased barren/degraded government lands.

6.3. Environmental Management of Development Activities that pose Land Degradation Risks

6.3.1. *Environment-friendly Road Construction*

- ✓ Make adoption of existing environmental codes of practices for road construction mandatory for all types of roads by enhancing legal provisions for EFRC in the Roads Act of Bhutan.

- ✓ Adopt the existing farm road development guidelines, including budgetary enhancement, as early as possible.

- ✓ Train Department of Roar (DoR) engineers, district engineers, private road contractors and contract engineers in EFRC approach and techniques based on existing ECOP and (approved) farm road development guidelines.

- ✓ Carry out cost-benefit analysis between roads built with EFRC techniques and traditional techniques.

- ✓ Provide all district engineering sectors the full range of road survey equipment necessary for alignment of roads in ways that can minimize adverse environmental impacts whilst optimizing socio-economic benefits.

6.3.2. Sustainable mining

- ✓ Review existing institutional mechanisms for the implementation of mining law and regulations, and strengthen/ revamp them to enhance law enforcement.

- ✓ Provide training support to private mining companies to develop their technical capacity for environmental management of mining operations and restoration of mined areas.

- ✓ Develop ECOP for mining activities and make its application mandatory through incorporation in mining law and regulations.

- ✓ In keeping with the Mines and Mineral Management Act 1995 and Mines and Mineral Management Regulations 2002, ensure all existing and new mining operations have mine plan, environmental management plan, and mine restoration plan as per acceptable standard stipulated by law, regulations and ECOP, and that these plans are being effectively implemented.

- ✓ Develop the capacity of the DGM and collaborating agencies, in terms of technical knowhow and skills as well as equipment and mobility, for monitoring, inspection, regulation and technical backstopping of environmental management activities of mining operations.

- ✓ Carry out cost-benefit analysis of various mining operations in the geologically fragile southern foothills fully taking into account factors of environmental sustainability, immediate, medium- and long-term social and environmental costs, and potential trans-boundary repercussions.

6.4. Strengthening of Systemic and Institutional Capacity

6.4.1. Policy and Legislation Development

- ✓ Develop a National Land Use and Management Policy (this could be possibly addressed through the soon-to-be developed National Land Policy/ National Spatial Policy).

- ✓ Formulate a National Mining and Mineral Development Policy laying out Bhutan's fundamental position and principles for mining to ensure equitable allocation and access to mineral resources, sustainable management of non-renewable mineral resources, long- term sustainability of mineral-based industries, and mitigation of adverse environmental impacts.

- ✓ Finalize the long due Grazing Management Policy and Act. Such a policy and law have been in discussion for a long time. Draft versions exist but they need to be expeditiously carried forward, refined, consolidated, finalized and enacted.

6.4.2. Strengthening Enforcement of Environmental Laws and Regulations

- ✓ Assess the institutional capacity and identify capacity needs, including clear delineation of inter-institutional roles and responsibilities, for the enforcement of various environmental laws and regulations. Strengthen institutional capacities based on the assessment.

- ✓ Enforce the full range of procedures and processes for environmental assessment and clearance on projects which inherently have very high potential of adverse environmental impacts. These would essentially include infrastructure development that involves use of heavy machinery, industries and mines.

- ✓ Develop the technical capacity of District Environment Officers and other members of DEC to more effectively implement the EA process.

- ✓ Develop the technical capacity of Competent Authorities within the line Ministries to more effectively implement the EA process.

- ✓ Develop NECS's capacity to carry out compliance monitoring of EA Act and Regulations, and provide technical backstopping to the Competent Authorities and DECs.

- ✓ Create public awareness of environmental laws and regulations, including their rights and responsibilities, to foster active public participation and support to law enforcement.

- ✓ Make all environmental laws and regulations accessible to the public. This could be among other things done by means of posting them on the internet as well as making them available for sale in bookshops.

6.4.3. Institutional Development

- ✓ Create a cross-sectoral agency, within NLCS or NECS, for overall technical coordination of national land use and management.

- ✓ Strengthen the institutional capacity of the Department of Disaster Management and District Administrations to effectively deal with natural disasters.

- ✓ Upgrade National Soil Service Center (NSSC) into an independent Ministry of Agriculture and Forests (MoAF) institution to enable it to coordinate and provide soil conservation and land management services across the three Renewable Natural Resources (RNR) sub-sectors of agriculture, livestock development and forestry.

- ✓ Establish a central weather organization supported by regional real-time weather stations for weather monitoring and forecasting. This will enable better preparedness for climate- induced natural disasters. In addition, creation of such an organization would improve management of hydrological and meteorological data which can be used for a wide range of purposes, including planning of roads and irrigation systems and monitoring of river sedimentation levels.

6.5. Information, Advocacy and Education for Policy and Public Support

- ✓ Carry out a country-wide quantitative survey of land degradation using Geographic Information System technology. This survey would need to assess the nature, extent and scale of land degradation and generate quantitative information to primarily inform decision- making, provide baseline for monitoring land degradation trends, support awareness raising programs, and aid planning of geographically-targeted actions to combat land degradation.

- ✓ Create a national website dedicated to land degradation issues, through which information views and solutions on land degradation can be exchanged. This website could also contain a "Bhutan-Land Degradation Information System", which could be developed using the data accrued from the land degradation survey (refer Action 1).

- ✓ Develop and use public information documents such as the Bhutan Environment Outlook/ State of the Environment Reports for advocacy and public education on environmental trends and issues. Produce and disseminate these reports in advance of the next Five Year Plans (FYP) to aid informed their formulation.

- ✓ Produce and broadcast a TV documentary series, highlighting land degradation trends and issues in the country, to create increased public awareness.

6.6. Recommendations for Rangeland Management

6.6.1. Policy

1. Revise and finalize draft feed and fodder/pasture policy to address the emerging challenges arising from fast economic development;

2. Develop a national strategy on the long term sustainable use and management of rangeland resources in the country;

3. Reintroduce prescribed burning to prevent encroachment of alpine meadows by woody species as validated by the finding of research centers; and

4. Develop and strengthen skills and capacity of rangeland researchers and extension staff as a Human Resource Development (HRD) policy.

6.6.2. Institutional

1. Develop core human resources mainly on rangeland ecology and management that shall be responsible and accountable for rangeland related programs;

2. Establish permanent research sub centers in the rangeland to undertake rangeland research in the country; and

3. Strengthen coordination and share resources among various institutions that have stake on rangeland.

6.6.3. Social

1. Understand and incorporate the indigenous knowledge of the herders into development interventions.

2. Encourage and facilitate community based rangeland management by herders by actively involving the herding communities in developing their management plan and bye-laws.

3. Ensure adequate social facilities through better connectivity to selected rangeland areas.

6.6.4. Land degradation

1. Identify the rangeland areas that are common grazing grounds for the highland and lowland cattle and develop location specific land management (including water) plan based on soil, vegetation, biodiversity and human activity database;

2. Undertake soil analysis of the rangeland and develop a database on soil nutrient status of different categories of rangeland.

7. References

Baillie, I., Dema, K., Dema, Y., Jamyang, Tamang, H. B., Turkelboom, F, Tshering, K., *Types of land degradation in Bhutan*, Journal of Bhutan Studies, 8, 88 – 114

Baillie, I., Norbu, C., Dorji, T., & Gyltshen, P. (2004) Land Degradation in Bhutan – An Overview. Journal of Bhutan Studies.

Bhutan Climate Summit 2011. Impacts of Climate Change on Food Security.

Chophel, P., (2009) Rangeland Management in Bhutan. A Consultancy Report, Ministry of Agriculture and Forests, Thumphu.

CSP, (2007). Country Strategy Paper, Bhutan

Dhital DB (2005) *Forest Resources Assessment and Potential Forest Areas for Sustainable Timber Production*. Paper presented at Annual Forestry Conference 2005, Thimphu.

DoA (2005) Land Management Campaign, 10-28 July 2005, *Field Report*. Department of Agriculture, Ministry of Agriculture, Thimphu.

DoE (200) *Water Resources Management Plan Final Report*, Volume A-Executive Summary. Department of Energy, Ministry of Trade and Industry, Thimphu

DoP (2005) *Millennium Development Goals Progress Report 2005*, Bhutan. Department of Planning, Ministry of Finance, Thimphu.

Gyamtsho, P., (2002) Condition and Potential for Improvement of High Altitude Rangelands. Journal of Bhutan Studies, Volume 7.

GNHC (2008) Tenth Round Table Meeting Report, 17th to 18th February 2008, Thimphu Bhutan

LCMP (2010) Bhutan Land Cover Assessment Report. Natinals Soil Service Centre, Ministry of Agriculture and Forests, Thimphu, Bhutan

LUPP (1994) *Atlas of Bhutan: Land Cover and Area Statistics of 20 Districts*. Land Use Planning Project, Ministry of Agriculture, Thimphu

MoA (1995) *Forest and Nature Conservation Act of Bhutan,* 1995, Ministry of Agriculture, Thimphy

MoA (2000) *Forest and Nature Conservation Rules of Bhutan, 2000*. Ministry of Agricultuire, Thimphu.

MoAF (2012) Bhutan RNR Statistics, RNR Statistical Coordination Section, Policy and Planning Division, Ministry of Agriculture and Forests, Thimphu.

NAPCLD (2009) National Action Program to Combat Land Degradation, Final Draft, Ministry of Agriculture and Forests, Thimphu.

NAPA (2012) National Adaptation Programme of Action, National Environment Commission, Royal Government of Bhutan.

NSSC (2007) Implementation *of the United Nations Conventions to Combat Desertification in Bhutan*, National Report, Ministry of Agriculture, Royal Government of Bhutan

Norbu, C., Karma, D. D., Jamyang., Yeshey, D., Kado, T., Tamang, H. B. & Turkelboom, F., (2000). Types of land degradation in Bhutan. Journal of Bhutan Studies. Pp 88-114.

RGoB (2000) *Bhutan 2020: A vision for peace, prosperity and happiness*. Bhutan,s Vision Document, Planning Commission, Thimphu

RGoB (2002) Ninth *Plan Main Document (2002 – 2007),* Planning Commission, Thimphu

RGoB (2008) *Bhutan Environment Outlook, 2008*. National Environment Commission, Thimphu

SFU (2005). Report on the long term study on soil fertility trend of the major farming systems in Bhutan. Report of Soil Fertility Unit, Ministry of Agriculture, Thimphu, Bhutan.

Tobgay, S., (2005) Small Farmers and Food System in Bhutan. Paper presented at the FAO Symposium on Agricultural Commercialization and the Small Farmer, Rome, 4-5 May 2005.

Turkelboom, F., Wangchuck, T., (2009) *Steep Land Farmers and Their Land Resources*: *A Holistic Land Degradation Assessment of Eastern Bhutan*. Technical Document No. **42**, Renewal Natural Resources Research Centre: Wengkhar, Mongar, Bhutan.

UNEP, 2001, State of Environment, Bhutan 2001, United Nation Environment Programme of the United Nations.

Country Paper: China

Wang Ying
Ministry of Water Resources, No.2, Lane 2, Baiguanlu Xuanwu District, Beijing 100053

1、Background

China is situated in the eastern part of the Eurasian plate, and has a ladder-like topography descending from west to east. The special geographic and climatic conditions lead to serious flood and drought disasters. The total quantity of water resources is roughly 2800 billion m^3, and water availability per capita is around 28% of the world average.

The precipitation and water resources in China are unevenly distributed in time and space, and this allocation does not match with population, arable land as well as social and economic development pattern. In the northern part of China, 64% of the land supports 46% of the population yet only contains 19% of the nation's water resources.

Out of the total area, arable land is around 120 million hectares, accounts for around 40% of the world average per capita.

2、Situation and trend analysis at country level

With rapid social and economic development and increasing population, china faces more and more pressures and demand on water resources and ecosystem, and the controversy between human and water resources is increasingly intensified.

The annual accessible water amount is 814 billion m^3, and in 2011, the total quantity of annual water use of the economy and society amount to 621 billion m^3. 2/3 is for agriculture use. And it may increase to 700-800billion m^3 in 2030; almost reach the ceiling limitation of accessible water amount.

Water pollution and degradation of ecosystem may aggravate in some regions, due to irrigational water development and intensified exploitation of nature resources.

Water and soil erosion will still the major degradation problem in the following decades. At current water and soil erosion rate, top layer of black soil in more than 900,000 ha. of the northeast may become thinner after 50 years, and rockification area may expand in the southwest.

3、Strategy and mid or long term plan

China has been aware of these challenges and takes ecological civilization building as the long term national strategy. The connotation of ecological civilization building is as follow:

-First, to establish the concept of respect for nature, harmony with nature, protecting nature. This is an important ideological foundation to promote the ecological civilization building, and a reflection of the orientation of the new values.

-Second, place ecological civilization building in a prominent position, and merge it into all aspects and the entire process of economic, political, cultural, social governance.

-Third, adhere to the national policy of saving resources and environmental protection. Insist on giving priority to conservation and protection, and natural recovery.

-Fourth, to achieve the transformation of economic development pattern into green, recyclable, and low-carbon development.

The fundamental purpose of promoting the ecological civilization building is to reverse the trend of ecological deterioration, to create a good working and living environment for the people, and strive to build a beautiful country.

We realize that the sustainable development of China will also contribute to the global ecological security.

The Key Tasks of Ecological Civilization Building:

-First, it is necessary to optimize the pattern of national spatial development, speed up the implementation of the main water functional zones strategy, and control land development intensity, adjust the spatial structure, to build a intensified and efficient production space, a livable and moderate living space, and a beautiful and picturesque ecological space.

-Second, it is essential to promote resource conservation on a comprehensive level, promote the fundamental change in the utilizing modes of resources, reinforce the overall conservation management, and dramatically reduce energy, water, land consumption, for a recyclable economy with higher efficiency and benefit.

-Third, we need to strengthen the protection of natural ecosystem and environment, implement major ecological restoration projects, enhance ecological production capacity, increase the efforts in water, air, soil pollution prevention and control, and actively respond to global climate change.

4、major resource degradation problems

We recognize that the benefits derived from mountain regions are essential for sustainable development. Mountain ecosystems play a crucial role in providing water resources to a large portion of the world's population; fragile mountain ecosystems are particularly vulnerable to the adverse impacts of climate change, deforestation and forest degradation, land use change, land degradation and natural disasters.

These impacts are more influenced on the environment and human well-being of China, since China has an area of 9.6 million km^2 with high land in the west and low land in the east. Mountains, hills and plateaus account for 2/3 of the total area. Due to typical geological and climate situations, numerous population and development, China is one of the countries confronted with the most serious soil and water erosion in the world.

The total area of soil and water erosion reaches 2.95million km^2, occupying 30% of the total territory, and almost all the provinces suffer from soil and water erosion in various levels. Soil and water erosion exists not only in rural areas, but also in cities, development zones and industrial and mining areas.

The soil and water erosion is degrading land and damaging farmland. During the recent 50 years, the damaged farmland due to soil and water erosion reaches over 3 million ha.

5、Major causes of soil and water loss

Except for reason of natural aspects, it is also caused, on the one hand, by China's huge population, shortage of resources, limited environmental capacity, over cutting, over reclamation and over grazing, and unreasonable utilization of water resources in the long history. On the other hand, as the economic growth has not transformed in its modes, the concept of ecological civilization has not yet been solidly developed, and the non-ecologically civilized behaviors are still quite often to be seen, such as neglecting protection during production and construction.

6、Influence of climate changes

The impact of climate change, and extreme weather conditions it produces, e.g., severe rainstorms, extreme high temperatures, are occurring more frequently in China. The frequency and intensity of these extreme weather events are causing more natural disasters including flood, droughts, typhoons and sandstorms. All of these heavily impact China's ecological system, society and economy.

7、barriers to adoption of soil and water conservation

Although 0.96 million km^2 eroded land has taken harness measures, there are still more than 1.8millionkm^2 eroded land urgently need harness. Control measures are required for 24 million ha. sloped farmland and 0.96million eroded gullies. And after the amount of eroded land that requires less efforts being harnessed, the rest tasks we are facing is more difficult and need more technologies as well as finance and labor input.

The Barriers and difficulties to solve the soil and water erosion problems are as follow:

-The amount of eroded land so large and very dispersive that finances support can hardly be sufficient.

-Insufficient capabilities and technologies on quantity and quality monitoring and assessment.

-Lack of awareness and knowledge of farmers.

-Economic incentives to the unreasonable exploitation and construction activities.

8、Best management practices: The success of watershed management approach after gradual researches and practices

After long-time practices in soil and water conservation, China concluded a creative approach of taking a small watershed as a conservation unit with an area of 10-50 km^2. In the small watershed, scientific planning is carried out, structural, biological and cultivated measures are optimally allocated, and management of mountain, water, farmland, forest and village are integrated. This approach integrates ecological, economic and social benefits, and makes gradual innovations and development in theory, practices, techniques and mechanism, so it becomes the most important and valuable experience in China's ecological

construction. At present, 50,000 watersheds were managed or are currently under management, and many successful models on watershed management emerged.

9、National action programs on soil and water conservation

China continuously implements national key projects of soil and water conservation in serious soil and water erosion areas including the upper and middle reaches of Yangtze River, the upper and middle reaches of Yellow River, Beijing and Tianjin, black soil area in Northeast, South and North Pan Rivers in the upper reach of Pearl River, water source of South-to-North Water Diversion Project, silt-dam project on Loess plateau. And the sediment into Yellow River and Yangtze River is effectively reduced, desertification is controlled, and black soil land is protected. The agricultural production situation and eco-environment are improved.

In the following 20-30 years, we will gradually carry out harness projects on sloped degradation lands and eroded gullies and discharge sediment has a remarkable decrease. To restore favorable eco-environment in most of eroded area; stop framing in steep-scope with contour farming and soil-conserving cultivation. In most severely eroded area, the tendency of soil and water loss has a dramatically decrease; the severity of middle level eroded land alleviate; The awareness of people for caring environment shall be enhanced, and education should be encouraged for building up their knowledge of legal terms. Human-induced erosion shall be strictly supervised and controlled. Soil and water conservation plan shall be worked out and implemented at all times of initiation of development and construction project. Effective protection shall be carried out in major human-induced eroded area.

For effective implementation of action programs in support of three Rio conventions, we should raise the awareness of the essential effects of water and soil conservation, and recognize the vital role of taking comprehensive measures to systematically solve the nature and ecological problems and degradations. The better knowledge and technical sharing is crucial to deepen our understanding of discipline of eco-system as an entirety, and better knowing the linkage between desertification, bio-diversity, and climate changes.

10、Conclusion

We determine to take an ecological civilization building way to enhance the protection of natural ecosystems and environment. We also need to vigorously carry out the comprehensive management including the ecological restoration of rivers and lakes, soil erosion, stony desertification prevention and control.

11、Reference

1) The report of the 18th National Congress of CPC states

2) Bulletin of the first national census for water

Country Paper: Indonesia

Syaiful Anwar
Deputy Director for Watershed Management Technique
Ministry of Forestry of Indonesia

I. Introduction

Background

Land degradation, climate change and biodiversity loss is likely to have a significant impact on Indonesia. As a tropical archipelagic country with one of the world's richest species diversity and longest coast lines, it expects to suffer a significant amount of damage as a result of rising sea levels. Changing climate patterns are expected to disturb agricultural and forestry sector, which has been badly affected by the severity of the El-Niño phenomenon in 1997-1998 such as forest fire. As a mountainous tropical country, Indonesia is suffering from severe soil erosion which has significant impact on land productivity and in turn increasing poverty. Indonesia thus has a great interest in mitigation of climate change, combating land degradation and biodiversity loss and has been participating actively in the international negotiation.

It is recognized that land degradation and desertification, climate change and biodiversity loss are interconnected and reinforce each other. Land degradation could cause loss of biodiversity and also contribute to global warming, therefore, for our better future degradation of productive land should be slowed down, prevented or even stopped and degraded land should be rehabilitated. It is known as zero net land degradation. One of pathways to achieve zero net land degradation is Sustainable Land Management (SLM).

Sustainable land management (SLM) options in the context of zero net land degradation are defined as those land use and soil/vegetation management practices that create a positive carbon, water, and elemental balance in the used land, enhance net primary productivity, mitigate climate change by absorbing atmospheric CO2 and sequestering it in biomass and soil, and can be adapted to environmental conditions (UNCCD Policy brief, 2012). Therefore, SLM should be adopted in national or regional action plan in combating land degradation, mitigating climate change, and biodiversity.

Objective

The objectives of this paper is to add thought in the review process of the existing regional action programme to combat desertification, land degradation and drought (DLDD), and in the formulation of a Regional Action Programme to strengthen regional cooperation on SLM implementation and enhance synergy between initiatives in support of three Rio Conventions.

II. Situation analysis in Indonesia

A. Resource management sectors (agriculture, forest, grassland, etc.): overview on historic trend (20 years or more) in each sector; country's mid- or long-term plan on each sector (for instance, attaining food sufficiency, increasing forest area in the country)

Indonesia is a country made up of over 13,000 individual islands. Of those, there are about 6,000 inhabited islands, and these constitute about 70 million ha (37% of 190 million ha of the total land area). Indonesia is the fourth most populous country in the world after China, India, and the United States. Indonesia is home to over 300 ethnic peoples, but almost 70% of the entire population lives on the island of Java, which accounts for a mere 6% of the land area of the country. Roughly 82% to 83% of the country's economic activity is concentrated in western Indonesia (Sumatra, Java, and Bali), clearly attesting to the severe disparity in levels of economic development in the country. There is also a significant disparity between Java and other areas.

About 130 million ha of Indonesia land is forest land, constitute of conservation forest (17%), protected forest (28%), production forest (48%) and conversion forest (7%). Almost half of the area is degraded and even deforested. The underlying drivers of degradation and deforestation often lie outside the forestry sector in the form of forces such as agriculture, infrastructure development, trade and investment policies and low enforcement. Land degradation is a major causes of the expansion of crop and pasture lands to the detriment of existing forests. Almost all new crop land came from clearing of primary and secondary forests.

Forests are almost everything for living creatures because forests provide food, firewood, shelter and medicine. Forest helps to stabilize soils, discourage erosion and maintain a steady supply of fresh water. Forests lock up atmospheric carbon, helping to stabilize the earth's climate. More importantly, forests underpin the economies of Indonesia and most developing countries. Then how do we manage the trade-offs between conservation and development?.

About 60 % of populations in Indonesia depend on agriculture but farmers are less prosperous group. Their income level is low, facing limited access to credit and insurance, devastating by unpredictable climate caused their adaptive capacity weaken. In the future, agricultural development in Indonesia is facing serious problems, such as:

1. Inclination of productivity and therefore need technology innovation.
2. Soil and water degradation caused soil sickness, fertility and pollution.
3. Flood and drought due to climate change which caused agriculture production decrease
4. Conversion and fragmentation of agriculture land

Main targets of agricultural development until 2014 are:

1. Achieving self-sufficiency and sustainable self-sufficiency,
2. Enhancing food diversification,
3. Enhancing added value, competitiveness and export, and
4. Increasing farmers' welfare.

In forestry sector, desirable condition in 2014 is improving forest resource quality and increasing forest benefit. Indicator of forest resource improvement is decreasing deforestation and forest degradation and successful restoration and rehabilitation measures. Meanwhile, indicator of forest benefit on national economy is GDP, employment, environment quality include in the context of watershed carrying capacity and climate change mitigation and adaptation.

B. Major resource degradation problems: major significant type of degradation problems along with their severity level; major causes of respective degradation problem (focusing on agricultural landscape)

Manifestation of land degradation includes accelerated soil erosion by wind, water, increasing salinization of soils and near surface ground water supplies, a reduction in the productivity of dry lands ecosystems, with an attendant impoverishment of the human communities dependent on these ecosystem. A combination of climatic stress and land degradation may lead in turn to extreme social disruption, poverty, migrations, and famine. Those conditions are commencing over several areas of Indonesia especially in the central and eastern parts of Indonesia.

Indonesia considers the great importance of the problem of land degradation, which affected many parts of the world. The serious problems were caused by many factors such as climate variations and human activities, as land degradation is not merely a matter of physical land degradation, but also about the people living in the degraded land. The most obvious impact of the degradation of resources is low agricultural productivity that can lead to widespread poverty.

In Indonesia, a country with more than 13,000 islands extending through the equator, high population growth rate and uneven distribution have severe pressure on land resources. From a population of 120 million in 1968, it has grown to 230 million in 2012. Without any positive intervention through appropriate environmental management programme, this trend may lead to land degradation.

A consequence of the population growth is an increasing demands to satisfy basic needs of a large number of people. Population pressures on land are mostly felt in densely populated areas of Java. To meet the demands of population, more forests have been converted to agricultural lands while on the other hand agricultural lands are converted uncontrollably to urban and industrial uses.

The extent of degraded land in Indonesia is increasing rapidly especially in the dry areas due to shifting cultivation, misuse of land resources, and over wild grazing. These practices resulted in shrub land, wasteland, and unproductive land, and in turn increasing poverty. The latest record of deforestation in Indonesia points out at a rate of 1.8 million hectares per year until 2002. Degraded land has reached 30 million ha in 2007 and recent data from the Ministry of Forestry showed little decreasing, about 27 million ha (Indonesia Forestry Statistic, 2012).

In the eastern parts of Indonesia, which is considerably drier, climatic factors contribute to the dryness and arid conditions in some parts of the islands. Some areas are in recurrent dry condition, for instance the islands of Lombok, Sumbawa, Sumba and West

Timor. Some areas even bear the characteristics of desert, as can be seen in some parts of Lombok, Sumbawa and Central Sulawesi.

Land degradation in eastern part of Indonesia is mainly characterized by the following features:

- Land and Savannah as caused by over grassing and land fire.
- Low rate of topsoil development caused by serious fire
- Thin layer of topsoil and rocky soil affected naturally by soil age, landslides and rill and inter-rill erosion
- High sedimentation rate in the downstream as caused by severe erosion and floods

To retain the worsening condition of the land, there had been some efforts done to improve the land condition such as reforestation and regreening program in 1980s. However, this program was unsuccessful because of the wrong approach and lack of community support. Because of that, to suppress the land degradation process, a community model approach is needed to be developed. One of the pre-requirements for that is involving many stakeholders (community, government, academic, NGOs, youth groups, religious groups, etc.) in the planning, implementing and up to the evaluating and monitoring the program. Nowadays, community participation on forest and land rehabilitation is increasing following the 'one man one tree' programme and now Indonesia establish planting one million trees programme.

Besides the need to strengthen its capability to control forest and land fire, Indonesia is expecting to explore effective efforts to mitigate the impact of drought, and to promote water management strategies aided by seasonal forecasting methods and other associated land degradation rectifying measures.

C. Climate change and role of climate change: climate change situation in the country; information needs for analyzing climate change impact on agriculture, forestry, etc.

Many of the extreme climate events in Indonesia, particularly droughts, were associated with ENSO. This was primarily due to the significant decrease in rainfall. Study has indicated that the effect of ENSO on dry season rainfall is stronger than on wet season rainfall. A significant reduction of dry season rainfalls could be expected during El Niño and significant increase during La Niña years.

1. Impact on Water Reservoirs, Electricity Generation and Drinking Water

The decrease and increase in rainfall has significant impact on water storage in reservoirs. Significant changes in water volume in the reservoirs (dams) occurred during dry seasons, in particular in dry season II (June-September). Many of these dams have functions for electricity generation and for providing irrigation, water and drinking water. The occurrence of ENSOs that caused significant decrease of water levels in the reservoirs has caused serious impact on electricity generation. In El-Niño years, most power plants in Indonesia produced less electricity than normal.

The shortage of water in the reservoirs during extreme dry years will also influence the availability of drinking water, especially in urban/metro areas. For example, Jakarta, the

capital city of Indonesia, gets drinking water from the Citarum Dam in West Java province. Under extreme dry years, the water level at Citarum Dam may go down to a level of less than 75 m. Under this condition, the water pump at the dam can not be operated and supply of water to processing the plant will stop.

On the other hand, in extreme wet years, the flood will damage the processing plant and contaminate the water. Floods occurred in February 2007 have caused damage in the production installation which amounted to about 2.2 million USD. Heavy rainfall also increases the turbidity and this will increase the cost of water processing.

2. Impact on Agriculture

The role of climate change on agriculture will vary overtime and across locations, depending on agro ecologies, farming systems, production condition and even particular plant species. Applicable solutions to the problem are stress-tolerant crop varieties, better practices for managing soil, water and other natural resources, new approaches to agriculture diversification, and policies that foster positive change.

Significant decrease in rainfall in dry seasons has significant impact on food crops production. From historical data, it was shown that, in general, the area affected by drought significantly increased during El Niño years. However, from national production statistics the impact of El Niño, apart from 1982, is not distinct, except for rice. This condition appears due to a number of reasons :

1) not all regions of the nation are affected by drought simultaneously,
2) shortage of water may force a farmer to switch crops from rice to secondary crops,
3) restricted water supply may reduce the area planted under irrigation but yield of crops may increase due to higher solar radiation, and
4) production may be affected in the year following an El Niño event as farmers have less money to spend on fertilizers or insecticides.

Data of historical impacts of El-Niño events on national rice production indicate that the national rice production system is vulnerable to extreme climate events. Whenever El-Niño occurred, the rice productions loss due to drought increased significantly, and the total loss also tended to increase. On average, the production loss due to drought in the period 1991-2000 was three times higher than that, occurring in the period of 1980-1990 (Boer and Las, 2003). This seems to indicate that the national rice production system becomes more vulnerable to extreme climate events.

The occurrence of ENSO also has indirect effects on crops. There was an indication that the brown plant hopper population increased significantly in La-Niña years probably due to higher rainfall amounts. Plant hopper attack in West Java, the main rice growing area of Indonesia, increased significantly in years when LaNiña occurs, i.e. 1998 and 2005. In addition, types of major crop pest and diseases have shifted recently. For example in the past pink rice stem borer (Sesamia inferens) was only minor problem in Java (e.g. Indramayu, Magelang, Semarang, Boyolali, Kulonprogo, and Ciamis) compare to yellow rice stem borer (*Scirpophaga incertulas*), and white rice stem borer (*Scirpophaga innnotata*). Nowadays this disease become dominant. Regions with distinct dry seasons are favorable for pink rice stem borer. Bacterial leaf blight (Xanthomonas oryzae

pv.Oryza) in the last three years is also dominant diseases for rice crop while before this disease is not important so that research on these diseases is still limited.

Similar phenomena is also observed in non-rice crops. For example, twisting disease caused by Fusarium oxysporum before 1997 is not important disease for red onion crop, but now this becomes very important disease not only in lowland but also in the highland areas. In the last two years, this diseases attack seriously red onion crops in a number of onion production centre such as Brebes.

The phenomenal example is the appearance of Gemini disease in chili in the last five years in all main chili and potato production centre of Java (Bogor, Cianjur, Brebes, Wonosobo, Magelang, Klaten, Boyolali, Kulonprogo, Blitar, dan Tulungagung; Nastari Bogor dan Klinik Tanaman IPB, 2007). This disease caused by virus which is transmitted to the crops by kutu kebul (Bemisia tabaci). Up to know, research on this disease is still limited. However initial findings suggests that temperature is the main triggering factor for this disease as indicated by the significant increase in Bemisia tabaci population on tomato when temperature was increased from 17 to 30 °C. The explosion of this virus under elevated temperature has been predicted by Boland et al., (2004) in Canada. These above findings may not be enough to conclude that global warming is the main triggering factor for this disease, however it is undeniable that global warming contributes partly to create this condition.

Long dry seasons in El-Niño years affect significantly not only annual crops but also perennial crops. Based on field observation, a long dry season in general destroys young plants. The impact of severe drought on some plantation crops such as coconut and palm oil may not occur during years of drought events but it may be observed a few months later (after 4-9 months).

3. Impact on Land and Forest Fire

The extent of land and forest fires in Indonesia is also closely related to ENSO events. In El-Niño years, the total area of land and forest being burnt by fires increased significantly and this lead to much of the increase in levels of atmospheric CO2. For example in the 1991/92, 1994/95 and 1997/98 El-Niño years, the carbon emission from fires measured in 97 monitoring stations across South East Asian countries increased significantly. Wildfires in Indonesia were responsible for much of the increase. Most of the carbon emission from fire in Indonesia during 1997/98 came from peat fire. Total area of fire-damaged forested peat land for whole Indonesia during this time might reach 6.8 million ha (Page et al. 2002).

Forest fires have a direct impact on the physical environment, namely on forest ecosystems as they disrupts forest function, stream pollution, decreasing watershed carrying capacity and reduction of biological diversity, while at the same time pollution of the atmosphere occurs. Air pollution, especially aerosols, produced by fires reduces visibility, disrupting land, air and water traffic. Visibility of less than one kilometer halts air traffic. In the case of 1997 fires, in some cities the visibility was only about 10 m. Diseases or health problems caused by air pollution include acute respiratory infection (ARI), bronchial asthma, bronchitis and eyes and skin irritation. The total number of

health cases during the 1997 fires in 8 provinces (Riau, West Sumatra, Jambi, South Sumatra, West, Central, South and East Kalimantan) reached about 9 million cases.

Total economic loss nationally due to the 1997 forest fires amounted to 662 and 1056 million USD. Furthermore, this fire was one of the top 10 natural hazards occurred in the period of between 1907 and 2007 and value of all damages and economic losses directly or indirectly related to the 1997/98 fires might reach 17,000 million USD, much higher than those reported by the previous two studies.

4. Impact on Coral Ecosystems

The increase in sea temperature during the 1997 El-Niño year has caused serious problems for the coral ecosystems. Wetland International reported that the 1997 El-Niño has damaged about 18% of the coral ecosystems in South East Asia. Coral bleaching was observed in many places such as in the eastern part of Sumatra, Java, Bali, and Lombok. In 'thousands islands' (north of the Jakarta coast), about 90-95% of the corals located 25 m below sea surface has been bleached.

5. Impact on Health

Extreme weather related to ENSO may also contribute to the outbreak of human diseases such as malaria, dengue, diarrhea, cholera and other vector borne diseases. This finding has been used as one of the indicators to warn the possibility of malaria outbreak. In Indonesia Dengue cases are also found to increase significantly in La-Niña years when seasonal rainfall increased above normal. A significant increasing trend in the number of dengue cases was also observed in Java. Based on data of dengue incidence rate from 1992 to 2005, it was found that in many big cities, especially in Java, the incidence rate of dengue increased consistently from year to year peaking in La-Niña years.

III. Barriers to adoption of soil and water conservation.

Barriers to adopt soil and water conservation measure could be related to technology itself, policy, institutional and socioeconomic factors. However, the most important is that soil and water conservation measures will gain acceptance among the farmer or rural masses only when socio economic consideration are adequately addressed. Soil and water conservation and watershed management technologies must be compatible with socioeconomic concerns in the area.

The socioeconomic compatibility is critically important and therefore the barriers to adoption of soil and water conservation are more socioeconomic rather than technical issue. The technology is available and training to implement it is already conducted but soil and water degradation such as erosion is still happening and the rate of degradation is increasing in some parts of the country.

This socioeconomic problem mostly occurs in upland area where soil erosion has off site economic impact in downstream. Recently, society awareness on off-site impact is rising but Farmers are usually more concerned only with on-site cost. As long as the cost of implementing conservation technologies are lower than benefit, farmers who already aware

of the importance of environment quality will adopt the technologies. Although they understand that during initial of technology adoption they usually gain nothing. If it is higher than benefit the technology will be rejected with many reasons.

With regards to stakeholders related to land in their activities, not only farmers in the upland, policy on soil and water conservation in the country is also necessary to enable soil and water conservation can be applied. In Indonesia, soil and water conservation act is being prepared for long time and finally the draft is in parliament already waiting to be discussed.

IV. Best management practices

The best management practices generally appropriate for soil and water conservation and also adapt and mitigate climate change may involve tree crops, horticulture crops, food crops, industrial crops, medicine crops, fish, and/or livestock depends on local conditions. The success of farming system practices depends on the combine effort of farmers, researches, extension workers and planners. Scientists, sociologists and economists work with farmers to understand the limits to production and sustainability at the farm level. This farming system practices bridges the gap between research and on-farm utilization while taking into consideration other influences such as markets, availability of labor, access to credit, level of surrounding infrastructure, extension support and government policies. The practices is known as Agrosylvopasture system and it was considered as the most appropriate farming systems for sustainable land management (SLM) and combating land degradation and alleviating poverty in Indonesia.

Taking the case of eastern part of Indonesia, Agrosylfopasture system has consistently increased productivity of the land. The Agrosylvopasture systems have increased food crops productivity, livestock ownership of the farmers, tree population, and farmers income significantly. The Agrosylvopasture systems also have increased the quality of environment, i.e. stream base flow, biodiversity, and carbon sequestration, and have extended economic activities and increased job opportunities (*Anwar et.al.,* 2012).

The increasing productivity of food crops is likely due to the using of additional manure from livestock of the Agrosylvopasture. Livestock ownership has been increasing from only 2-3 goats/sheep to 6-7 goats/sheep. The foodcrop productivity increased, an example for rice, from only 1.4 ton/ha/year to 2.5 ton/ha/year. Tree/firewood production has been increasing from almost nothing to 1500-6400 trees/ha. From the increasing productivities, the systems have increased farmers income from USD 72- 333/year to USD 2716-5933/year.

The agrosylvopature system have also increased hydrological function of the watershed indicated by the emerging of spring waters in many parts of watershed and increasing biodiversity and carbon sequestration; even though these phenomena were not observed systematically yet.

The most importantly that the agrosylvopasture is a best practices was shown from the number of farmers to adopt the systems has been increasing year after year. The farmers involvement are increasing from only 69 farmers in the first year of the project to 15,000 farmers in 2007 and keep increasing to 17,000 farmers in 2012. This is likely due to

successfulness of the system to increase farms productivity and farmers income and restore environmental conditions.

The Agrosylvopasture systems have also extended economic activities and job opportunities of the farmers all year around from only 4-6 months during rainy seasons before the implementation of the systems.

V. National action programs on soil and water conservation

Programme on soil and water conservation in Indonesia has been formulated in national action programme to combat land degradation. Currently the action programme is under revision process to be aligned with 10 year strategic plan of UNCCD as a global mandate.

The basic principles of the national action programme framework to combat land degradation are sustainability, national commitment, and integrated approach. The revision of the national action programme will add synergy measures between three conventions.

The essence and main purpose of the National Action Programme (NAP) for Combating Land Degradation (CLD) are to undertake consistently sustainable management of land resources which involve not only natural resource management, but also institutional and infrastructure development with full consideration of community (socio- economic conditions).

The National Action Programme to combat land degradation (NAP-CLD) must be backed up by the long-term commitment of all parties concerned, particularly at political and decision-making levels, as well as bottom-up planning and local community based undertaking in the process of NAP-CLD. Program planning and implementation will be undertaken by local community.

This NAP approaches land degradation control comprising several inter-dependent elements in a dynamic equilibrium within the context of sustainable land resource management, social and economic development particularly poverty alleviation and environmental stability. Mitigation of drought impact is also part of the programmes.

The strategy of action programme are:

1. Public support and participation is critical for applying and implementing methods of prevention and rehabilitation control.
2. Developing a partnership with local institutions and community and non-government organizations for an effective implementation of land degradation control.
3. Co-ordination with implementation of CCD and CBD for synergic and effectiveness of the needed supports and resources.
4. Strengthen co-operation with related regional institutions, regional CCD Thematic Programme Networks and international organizations.
5. Developing the capacity to be better consolidated, manage and deploy existing financial resources (APBN, APBD) and strengthen the capacity to negotiate with international and national agencies for increased financial support.
6. Establishing priorities and development of action plans though active involvement in the decision-making by local communities in the implementation, monitoring and evaluation.

7. Full participation of representative community should be engaged in all level activities (planning, implementation, monitoring, and evaluation)
8. Use best practice knowledge and robust technologies including traditional knowledge and wisdom.
9. Awareness rising about good quality environment and sustainable agriculture development
10. Project should be holistically concern about the unique characteristic of the community in the respective degraded land (integrated and sites special project)
11. Project should concern on long-term security investment through a good and attractive land tenure system.

Thematic Programme & Projects of the national action programme to combat land degradation in Indonesia that has been formulated include:

1. Providing Enabling Conditions
2. Land Degradation Inventory and Monitoring
3. Promoting of Agroforestry
4. Monitoring and Mitigating the Impact of Drought
5. Prevention of Land Degradation
6. Rehabilitation of Degraded Lands
7. Improvement of irrigation facilities and Water Conservation
8. Sylvo and Agro-pastoral Development
9. Monitoring and Evaluating of Climatic Variation
10. Empowerment of Local Communities and Local Institutions
11. Establishment of Sustainable Land Management
12. Providing Guidelines and Manuals
13. Creating and improving market systems

The future plan, Indonesia will integrate and synergize three Rio convention into national action plan to combat land degradation in order to achieve zero net land degradation by 2030.

VI. Conclusion/recommendations

Currently, land degradation in Indonesia due to soil erosion is continuing. Intervention through national action programme to combat land degradation have been made by thematic programme such as rehabilitation of degraded land. National movement also lighas been conducted, through activities such as one man one tree and one billion tree for the world. Net land degradation could be decreasing but not significantly because land degradation prevention programme is too weak.

The implementation of technology which is accepted by community in term of socioeconomic is a big challenge for the government. To convince community that soil and water conservation technologies will benefit either onsite or offsite need a big effort of the government. The other challenge is to convince that by applying soil and water conservation measures will mitigate climate change and biodiversity loss and then mainstreaming it into national programme.

Recommendation for ASOCON action programme that are going to be formulated during expert consultative workshop in Bangkok is to align with 10 years strategic plan and framework to enhance the implementation of UNCCD to enable ASOCON country member to synergize their measures into UNCCD implementation.

VII. References

Anwar, S., Sinukaban, N., Tejowulan, S. 2012. Sustainable Land Management to Enhance Food Production of APEC Member. Chiang Mai – Thailand.

Government of Indonesia. 2007. Indonesia Country Report: Climate variability and climate change, and their implication. Jakarta – Indonesia.

Government of Indonesia. 2007. National Action Plan in Addressing Climate Change (*Rencana Aksi Nasional dalam Menghadapi Perubahan Iklim*). Jakarta - Indonesia

Government of Indonesia. 2002. National Action Programme for Combating Land Degradation in Indonesia, in relation to UNCCD. Jakarta - Indonesia.

Ministry of Agriculture. 2010. National Strategic Plan 2010-2014 of the Ministry of Agriculture. Jakarta-Indonesia.

Ministry of Forestry. 2010. National Strategic Plan 2010-2014 of the Ministry of Forestry. Jakarta-Indonesia.

UNCCD Secretariate. 2012. Policy Brief on Zero Net Land Degradation: A sustainable Development Goal for Rio+20. Bonn-Germany.

Country Paper: Mongolia

Rangeland degradation and insecure tenure in Mongolia

Professor D.Dorligsuren, Executive Director, Mongolian society for Range Management

I. Introduction

Agricultural sector, especially livestock husbandry is one of the main sectors in Mongolian economy, and it produces 21 percent of GDP. Mongolian rangeland is vast, but very vulnerable, and it occupies 112.8 million hectares or 72.1 percent of the total territory. The grasslands providing forage for the livestock are severely degraded due to natural factors such as climate changes that have already occurred, and factors mainly caused by human behavior such as taking advantage of free grazing and access to water without managing this natural resource in a sustainable way. About 70% of the pasture area is degraded in some form. Yet despite this poor state of the pastureland, the number of animals has sharply increased. The present condition and the clear risk for further grassland degradation are cause of alarm that in the future it will be even more difficult to provide the necessary amount of feed for the livestock. Because the Mongolian conditions make seasonal and inter-annual movement of livestock a necessity, privatization of the rangeland is not possible, and *reducing open access via collective action is the only way to reduce pasture degradation.* This conclusion is reinforced when we consider that collective action will also be *required to put in place the measures needed to mitigate the impact of climate change*, such as development of wells and irrigation, hay making, and improvements in pasture productivity.

To adapt to climate and social change or to sustain and develop their life, a single herder household can't use pasture land separately in pastoral, nomadic, livestock husbandry. It requires that herders must cooperate together as herders' community for managing rangeland. Therefore, the establishment of territory based, herders' self-governing organizations is the main ways and means of solving numerous urgent problems of developing agriculture and rural society in Mongolia.

The territory based, herders' communities in Mongolia are established on the basis of defining boundaries of pasture land resources to be used, forming resource user groups, determining property rights, making clear the institutional systems and strengthening relationship between resource user groups and state organizations. Only such a herder organizations are able to adapt and can be more flexible to climate and socio-economic changes.

II. Situation analisis at country level

a. Resource management sectors

Mongolia has a territory of 1.56 million hectares of which 74% comprises of agricultural land, 0.4% of residential area, 0.3% of road and infrastructure network, 9.1 % of forest, 0.4% of water, and 15.9% of land for special needs according to 2012. In 1970s,

agricultural land used to comprise 92%. This indicates that agricultural land decreased by 19% and the other lands increased. Residential area, road and infrastructure network and land for other usages increased, whereas water and forest lands decreased. When looking at the current situation of land usage of Mongolia, 73.8% of the total land comprises agricultural land and 98% of that is pastoral land. Annex-1.

Agricultural land is divided into two main components which are **arable land** and pasture. Arable land covers 1.4 million hectares of area which holds approximately 1.5 of the total agricultural land. Mongolia started crop production in the late 1950s. Crops and vegetables which are suitable for the country's climate are grown; 70-80% of the total arable land is used for growing wheat whereas potatoes and vegetables are grown relatively less. In 1989, Mongolia has cultivated on the biggest area, which 720,000 hectares out of 1,375,000 hectares of the total land was cultivated. That year was the last year of socialism in Mongolia when the country transited from centrally planned economy to market economy. Since then, plantation decreased each year and reached to 139,000 hectares by 2007 and 2008, which was decreased by 5 times. This shows that the arable land was barely cultivated in the last 20 years. On one hand, it was due to the privatization process which the big state enterprises were split into small businesses that faced financial shortage and were unable to renew their equipment and machinery. This resulted in substantial decrease in cultivation which literally stopped. On the other hand, there was a drought each year during 1990-2000 and small plantation entities lost harvest which made them incapable of continuing cultivation. During that period, 900,000 hectares of the arable land became fallow due to climate and other factors but cultivation process has been restored since 2009. Arable land has been damaged and the soil has been degraded. Main reasons for soil degradation are due to climate's influence as well as lack of soil processing technology. On one hand, wheat-fallow cropping system has an advantage of keeping the soil moisture, but on the other hand, loose soil of the fallow land is blown by the wind and the soil gets damaged. In order to maintain stabilization of the arable land and prevent from soil degradation, the following measures need to be taken: 1. wheat-fallow cropping system needs to be replaced by wheat-alfalfa growing rotation system. Planting leguminous plant in rotation of wheat has two advantages. First, it helps soil improvement and stabilization. Second, the leguminous plants can feed cattle and meat farms can be established to fully meet the domestic demand for meat and export meat overseas, moreover can become the main meat importing countries of the two neighboring countries Russia and China. Implementing such state policies can benefit both ecology and economy. Alfalfa planted land cannot be used for planting wheat for 2-3 years, thus can result in decrease of wheat plantation and income. In order to solve this issue, the government needs to support and give subsidy to farmers who planted alfalfa. 2. Instead of ploughing the arable land, a cultivating method and zero tillage are appropriate systems in Mongolian windy and arid climate condition.

Forest land covers approximately 10 percent of Mongolia's total territory. Although the usage of forest has increased in the recent years, it is reported that the size of forest land has increased due to the forest remediation, planting trees and conducting research but the amount of forest has not increased much. The government has been taking a number of actions to restrict the uncontrolled uses of forest and to allow exemption from import tax and value added tax for importing trees and wood products

Water which is the most precious resource of Mongolia has been decreasing each year. In the recent years, surface water is measured once every 4 years. 23.5% of springs and lakes dry up in the years of drought and 14-15% of the surface water dries up in the normal years. The study shows that surface water has been substantially decreasing due to the global warming.Annex-2.

As for Mongolia, pasture is the most important land. This study aims to emphasize the current condition of Mongolia's pasture, its degradation, reasons for degradation and strategy for improvement.

b. Pasture degradation

As a result, appropriate relations between pasture land, livestock and herders as the main components of pastoral livestock husbandry have been lost. In 1960-1990, 130 thousand herders look after 24-26 million head of livestock on 125-130 million ha of pasture land. However, as of 2012, 290 thousand herders look after 41 million head of livestock on 113 million ha of pasture land. For the last 40 years area of pasture land decreased by 15 per cent, pasture yield by about 30 per cent (L.Natsagdorj, 2006) and species composition – by two folds (D.Avaadorj, 2006). However, for the last 20 years number of livestock increased by 1.7 times and that of herders by 2.7 times. It leads to ecological deterioration, degadation of pasture land and desertification. Researchers noticed that 70 per cent of the total pasture land – the base of nomads' livelihood have been degraded to some extent.(D.Avaadorj, 2000; D.Dash, 2000; ME, 1996; Ts.Shiirevdamba, 2000 D.Erdenetuya; 2006).Degradation of pastureland has accelerated sharply in Mongolia over the past 20 years.The degradation of pastureland accelerated particularly fast as a consequence of herding controls being replaced by open access during the transition from socialism to the market economy.It is mainly driven by concentration of herders near infrastructure and water points, and the reduction in seasonal rotations.Herders with small herds rotate less than the ones who own bigger herds.Increases in livestock numbers have led to stocking rates in excess of the carrying capacity.Climate change is exacerbating the trend of pasture degradation and the vulnerability of herders

Open access: Lack of institutions

The root causes of the pasture degradation are open access and the collapse of herders organizations after the transition to the market economy in 1990. Open access to common pastureland serves as one of the main reasons for overgrazing. The tragedy of commons by Garret Hardin(G.Harden.1968) really occurs in Mongolia. The state owned pastureland is used by herders freely leading to degradation and desertification of pastureland. There is no mechanism in place to limit or stop degradation of pastureland. Herders prefer to increase the number of their livestock as a main source of income generation. It leads to deterioration of natural resources. So, there is an urgent need to select or choose better forms of property rights (state owned, private and owned by community), develop an appropriate pasture management and set herders' self-governing institutions.

The sociopolitical and environmental management systems of Mongolia have changed dramatically over the past century undergoing many political and socio-economic

transformations. Especially, the period of democratic transition of the last 15 -18 years has resulted in fundamental changes in animal husbandry and natural resources management policies and practices. In Mongolia, functional customary and formal institutions were replaced by the collective system in 1960, which also provided formal institutions to guide pasture use and allocation. During the collectivization era in 1950-1990, pastoral land was used by collectives and the national herd grazed the natural pastureland in an organized and controlled manner. Water points were developed throughout the pasturelands at strategic locations to allow better utilization of the pastures where water had not previously been available. Under this system, there was some degree of management of the two basic natural resources – pasture and water. Employees who were tending the livestock would be given clear instructions as to where the animals could be grazed and for how long in that location so as to provide maximum feed for the animals yet at the same time, not degrade the pastures through overgrazing. Not only were livestock numbers and the herd/flock relatively stable (as was the species composition) mandated by the state as each collective had to generate certain production targets, but the grazing patterns developed did not place excessive demands on the pasture being grazed. State collective farms were major institutions that regulated pastoral movement to support extensive livestock production. In addition, state collectives were responsible for the wellbeing and development of rural communities and herders. The collectives played a significant role in allocating pastures and campsites and directing seasonal movements, often respecting pre-existing customary rights, but seasonal movements between *soums* and *aimags* were regulated and tightly controlled (Fernandez-Gimenez, 2001). Pastoral land use practices remained mobile where herding families were generally supported by trucks and deliveries of hay and thus had a less dramatic impact on the landscape than at present.

After the collapse of the socialist system, a number of detrimental impacts have been observed that resulted from the privatization process including (i) the creation of a large number of small scale producers that have introduced significant marketing complications, (ii) significant levels of conflict (individualism and competition) between different users of pasture land, (iii) pasture degradation through overgrazing as the small herders did not want to undertake lengthy grazing routes far from the urban centers as they needed to supplement their incomes from non herding activities, (iv) extensive destruction of water points throughout the pastoral areas – in the struggle of survival after the collapse of the socialist system and also through lack of any maintenance as there were no effective “owners”, and (v) an effective void created for input supplies and access to technical support services

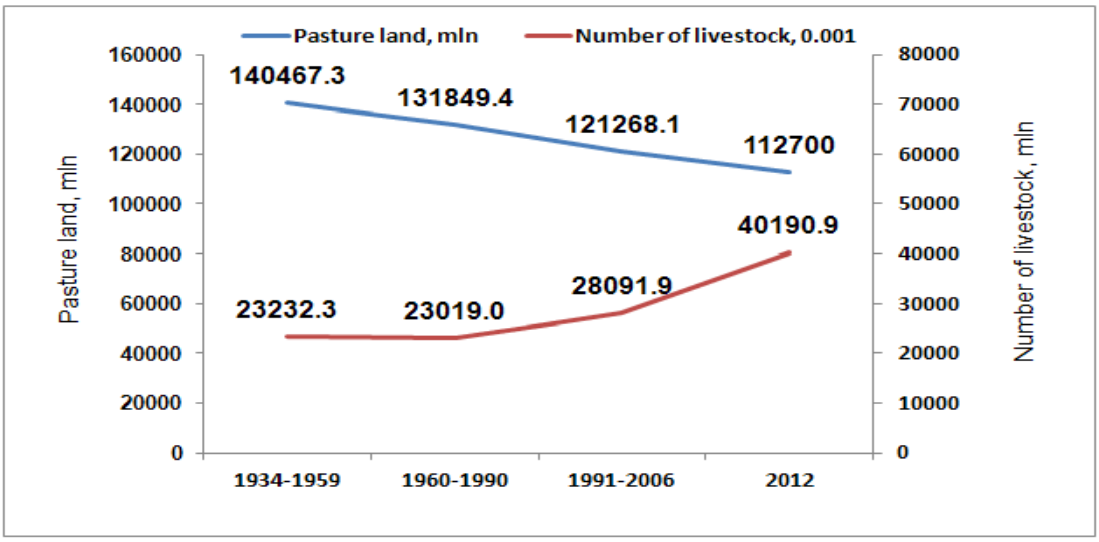
In weak communities where real ownership and management over the natural resources are lacking there is free and uncontrolled access to natural resources. This institutional void, together with the increase of herding households, and economic shocks to the pastoral sector from privatization, resulted in increasingly unsustainable land use patterns among pastoralists as many failed to make traditional seasonal movements and occupied the same pastures year-long, in violation of custom.

Pasture Carrying Capacity

From 1950 to 2012 the number of livestock increased by 178 % while pasture area decreased by 20%. In 2012 years the number of animals exceeds the carrying capacity of

pasture land by 32.5 % or by 16 million sheep units at national level. This leads to severe degradation of Mongolian pastures.

Changes in pasture land and number of livestock.



Herders have unequal possibilities to invest in pasture improvement depending on their herd size. In general they are not interested in investing in improved pasture land due to insecure use rights.

In recent years, herders who have experienced pasture shortage are trying to organize themselves, to secure access rights and then to invest in pasture improvement like digging manual wells, fencing winter camps (in forest steppe), producing hay etc.

Decline in seasonal migration

Dismantling of collectives has left herding households without clear directions about their rights to use pastureland that resulted in decreased movements around seasonal pastures. In the central region closer to the central market system, competition for and conflict over grazing land has been increased and to guard their winter-spring camps from trespassing, herders preferred staying there all throughout the year without having seasonal movements. Or to have only bi-seasonal rotations (winter-spring and summer-autumn)(Box 1). Non-local herders who do not follow any rules contribute much to this problem.

Box1. Number and seasonal moves by herders

The number and distance of seasonal moves by herders vary significantly depending on the herders' experience and their number of livestock. An example of this is B.Enkhbat who lives with his 70 livestock in Khujirt, *Khukhnuur bag of Ikh-tamir soum, Arkhangai aimag. B.Enkhbat moves 4 times a year with the distance of all his moves totaling less than 40 km. Such a move ranges from 4 to 11 km distance. Herder Ts.Dorjsuren, who looks after the highest number of livestock in his bag (2300 animals) moves 6 times a year traveling up to 280 km from one side of the bag territory to the other. In general herders with fewer animals move less often and shorter distances than herders with large herds. Compared to herders with less numbers of livestock, the average move distance traveled by the wealthy herder was 4.7 times higher and total move distance 6.7 times higher. The main reason for this difference is that the poor herders depend on additional income opportunities and do not have means of transportation to move frequently nor enough skill and knowledge in the area of managing pastoral livestock.*

Migration of herds towards non-degraded areas:

Pasture land area and number of livestock of different ecological zones vary significantly. In forest steppe zone with 24.9 million ha or 22.2 % of the total pasture land, 42.7 % of total number of livestock are kept. In desert area with 16.4 million ha (14.6%) of pasture land only 5.2 % of livestock are kept. The number of livestock per 100 ha varies from 20 sheep unit in desert to 111 sheep unit in forest steppe zone. An extensive migration of herders to forest steppe zone or from degraded areas to non-degraded areas bears the risk of forest steppe zones degradation in near future.

Concentration of livestock around infrastructure, water points and urban centers:

Concentration of livestock around infrastructure, water points and urban centers led to conflict over pasture access and its carrying capacity. This leads to severely degraded pastureland in the vicinity of populated areas such as aimag, soum and bag centers.

Vehicle tracks and Mining sector

According to Land Classification Information (2003), there are 282 thousand ha of vehicle tracks and 123 thousand ha of mining land area. The Administration of Land Affairs, Geodesy and Cartography cites other figures: According to them there are 517 thousand ha or 0.46 percent of the total pasture land affected by vehicle tracks and mining sector. There is not enough rehabilitation work done after gold mining which leads to soil destruction.

In the recent years, mining sector has been developing intensively and land for mining uses has increased greatly. Although it has significant benefits for economic growth, it has negative effects on sustainable management of pasture and land. In 2003, 63.7 million hectares of land was used for mining whereas in 2013, 215,1 million hectares of land has been used for mining. In other words, the land for mining uses has increased by 3.4 times. Inadequate mining reclamation reversely affects the pasture degradation and herders' livelihood. Therefore, mining reclamation and improvement of unused land are needed.

In addition to the decline in the vegetation cover there is an alarming reduction of the number and quality of plant species. From 1961 to 2006 the number of plant species decreased by 23.6 % in the desert steppe and desert and by 50 % in forest steppe (Figure 1). Grass species were replaced by poorly palatable weeds and shrubs, resulting in the decline of productivity and vegetation cover of the pastureland.

A dramatic decrease in the productivity of the rangeland was reported by herders and researchers. The pasture productivity was decreased by 28.6 % in desert area and by 52.2 % in steppe from 1961 to 2006 (Figure 2).

Figure 1. Changes in number of plant species (D.Avaadorj, 2006; N.Lkhagvajav, 2006)

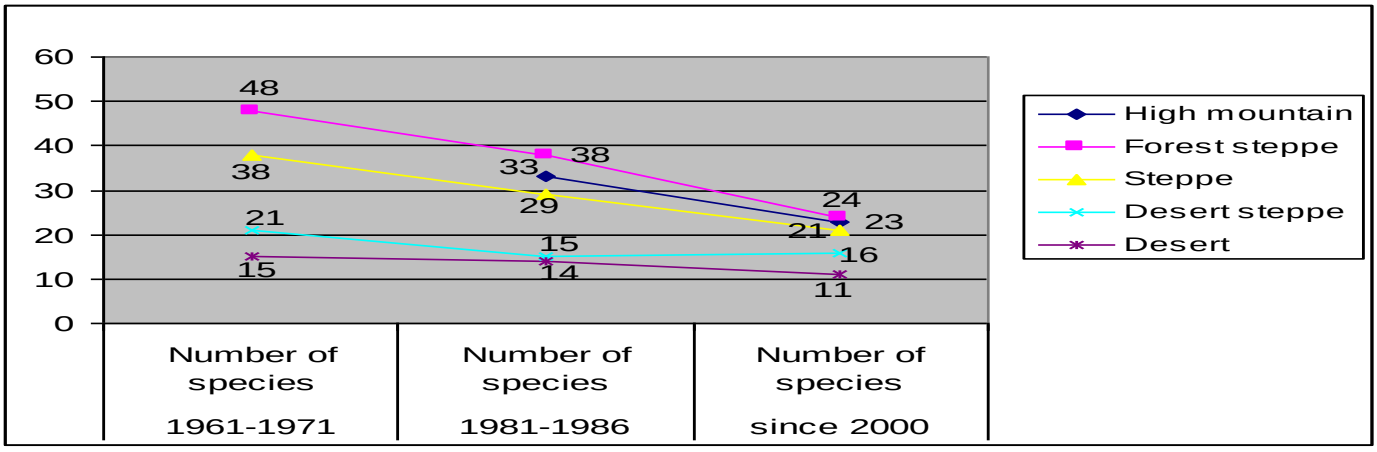
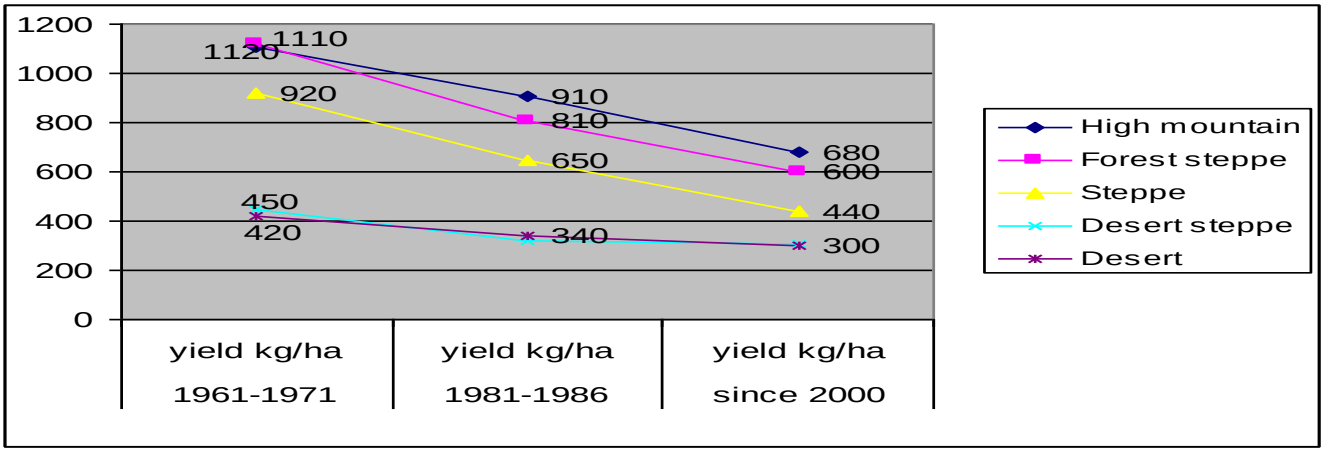


Figure 2. Changes in yield of pastures (N.Lkhgvajav, 2006; D.Avaadorj, 2006)



Heavily degraded pasture land creates many problems: (i) it reduces income from livestock and increases the risk of disasters with heavy losses of livestock (dzud); (ii) it impairs ecosystem services as C-sequestration or maintenance of biodiversity; (iii) through increased wind and water erosion it leads to an irreversible loss of the fertile soil, (iv) affects the country's economic capacity, environmental assets and even threatens its nomadic culture.

c. Climate change and role of climate change

Throughout Mongolia the climate is extremely continental. **Temperatures fluctuate greatly**, both daily and annually. July is the warmest month, with mean temperatures between **15^{0}C** in the mountains and **20 to 30^{0}C** in the southern semi-deserts and desert. The lowest temperatures are recorded in January, with monthly averages under **-15^{0}C** and minimum temperatures as low as **– 40^{0}C**. The annual average temperature in Ulaanbaatar is - 0.8 ^{0}C**. During the last 65 years, the annual mean air temperature in Mongolia has increased by 1.9^{0}C-2.1^{0}C.**

Precipitation is generally low, varying within the different ecological zones. It ranges from less than **50 mm** per year in the extreme south (Gobi desert region) to about **500 mm** per year in certain areas in the north. The average countrywide precipitation is about **230 mm** per year. During the last 65 years, annual precipitation has decreased by up to 12.5 percent

in central and desert regions an increased by up to 9.3 percent in other regions. These changes have affected environment, desertification, water supply and natural disasters leading to financial, environmental and human losses. The future climate scenario for Mongolia projects changes such as increased air temperatures, increased precipitation amount in some areas and reduction of water resources and arable land. Potential evapotranspiration increase would be higher than precipitation amount increase. The most vulnerable areas in Mongolia are the agricultural, livestock, land use, water resources, energy, tourism and residential sectors. Future climate changes are expected to negatively impact mostly the agricultural and livestock sectors, which in turn will affect the society and economy of Mongolia. This is an issue that needs to be taken into serious consideration.

Due to higher temperature it is expected that through **evapo-transpiration** more water will be lost to the atmosphere. About 20 to 24 % of all rivers, springs and lakes have run dry between 2007 and 1990. One of the reasons may be the change of vegetation cover and water retention capacity of the soil. This change leads to decreased water supply for ecosystems and human activities.

III. Barriers to pasture land conservation

Lack of legal environment

Land use regulation and patterns: Collectives /1960-1990/ have enforced seasonal moves and *otor* took care for emergency fodder fund and reserve areas. Since 1990, no more regulations enforced and frequency of seasonal movement declined.

Land tenure and Legal Framework: During the Collective period, all property was state owned and collectives allocated pasture according to the customary rights. Any disputes resolved by brigades and collective meetings under the inter-territorial use agreements. There was legal reform with new Constitution of 1992.**In the article 6.3 of Constitution:** The State may give for private ownership plots of land except pastures and areas under public and special use, only to the citizens of Mongolia. **The law on Land:** 52.2 Summer and autumn settlements and otor reserve pasture are allocated to baghs and hot ails and should be used collectively. Relying on pasture productivity and a herder's suggestion of the year, the grazing and resting period of winter and spring settlement pastures should be approved by the soum or district governor and implemented by the bagh governors and communities. In order to protect and restore some parts of winter and spring settlement pasture, referring to ecological zone, traditional knowledge of pasture use and its carrying capacity, a soum governor may provide access for herders to utilize certain pasture based on by bagh public meeting to communities on the bases of agreement and conditions.

The prevailing legal environment and/or its implementation have not been supportive to address the problem of open access to pasture land and the resulting widespread range land degradation and desertification in Mongolia. While local authorities already have sufficient legal rights to allocate winter/spring campsites, and pasture use rights in the winter and spring camp areas, these rights are not yet shared with the territory-based self-governing institution that so far lack legal recognition. Neither the soum governor

nor the PUGs have the formal rights to delineate and enforce their entire territories. Therefore one of the necessary conditions to reduce or eliminate the open access issue is missing. On the other hand, the legal basis for collective and individual actions to improve productivity of pasturelands or animals is better developed, for example in the right of soum governments to allocate use rights over hay making areas, and the possibility of PUGs to register either as NGOs or as cooperatives.

Lack of herders resource (pasture) management institution (HSGI)

Since 1999, Mongolia has become a *de facto* testing-ground for community-based rangeland management, with the establishment of over 2000 "herder groups" and "pasture user groups," facilitated by over 12 different donor and NGO-sponsored programs. Where 206 herders groups are considered to be business cooperative (11 percent), 355 herder groups are registered as NGO (18 percent) and 1396 are classed as informal groups (71 percent). [1]

Most of these projects aim simultaneously to enhance pasture management and productivity, while improving herders' livelihoods through increased education, capacity-building, livestock improvement and marketing, and/or livelihood diversification opportunities.

The bottom line is that the territory-base approach to herder organization is very promising, but that the various project approaches differ significantly in their effectiveness and likely sustainability. None of them has yet progressed to enable a control of animal numbers in cases where, after reducing pasture degradation and improving productivity via the PMPs, the number of animals would still be unsustainable. However, strong territory-based herder organizations appear to offer the only way towards eventual introduction of control of animal numbers.

IV. Best /appropriate management practices

Question was how to tackle the open acsess and free riding ? Who is ? Many answers to this questions.Somebody suggested individual, private people is more appropriate and to privatize the pasture land to individual people,others likes Government and to manage pasture by the Government, third ones likes community and to thansfer the property rigths to the herder's community. **The use of natural pasture land is regulated by definite regimes that are embedded in the institutions. A question "What kind of institutions should be established in nomadic herding system?" is still waiting for its answer. There are three main concepts to solve this issue.** Organizing of sparsely distributed herders' households into an community based institutions is key issues for solving the difficult problems accumulated in nomadic livestock husbandry.

1, Gunther Mau, J Chantsallkham, Herder Group Evaluation , A study of herder groups, their present status, and future potential , UNDP, Mongolia, 2006

The first concept is a top down approach based government organizations, because pasture land is owned by the government. The state is a owner and manager of pasture land. Herders are only users. This concept was approved and implemented in existing Land Law, other legislations and resolutions. But, such a policy and decisions have not been implemented for the last 20 years. If its implementation was well, we don't have any degradation of pasture in Mongolia. There are no possibilities to implement this policy on grass root level in the real herding practices. The reason is difficult to realize all these centrally in the condition of sparsely distributed pastoral herding system. However, the Government should provide herders' self-governing institutions at grass root level with economic, financial and management support and training .

The second concept is based on private property, in other words, establishing pasture management **institutions by giving pasture land to individuals** for possession or ownership. This concept could not be implemented in Mongolian condition with its pastoral livestock husbandry. It is connected with the following reasons.1) Huge area of Mongolian natural pasture land is to be used commonly by sparsely distributed nomadic herding communities (herder groups, pasture user groups etc,) 2)with flexible seasonal movements if we want to manage pasture land properly.3) Mongolian pasture land is directly dependent on natural and climatic conditions. The only way to mitigate the risks is seasonal movement. There is no possibility to prepare forage for feeding all livestock. There are not enough hayfields also. So, in current situation, there is no possibility to divide pasture land and allocate to individual herder households in Mongolia.4).Traditional nomadic herding approaches are set deeply in mind and daily practices of herders. Herders have indigenous knowledge and skills for livestock and rangeland managment.We cannot change all these traditional and customary norm and indigenous knowledge and skills.5). Genitics of local animals have more adopted to the hash condision over the long time. It is impossible to change. Allocation of pasture land to individual herder households would not support nomadic herding system in Mongolia. 6).Fencing of allocated pasture land is too expensive not only for herders but also for the government.The surveys conducted among herders, results of experiments carried out by scientists and international practices show that this concept could not be implemented fully in Mongolian condition with its nomadic livestock husbandry.

The third concept is bottom up approach based on herders' self-governing organizations.

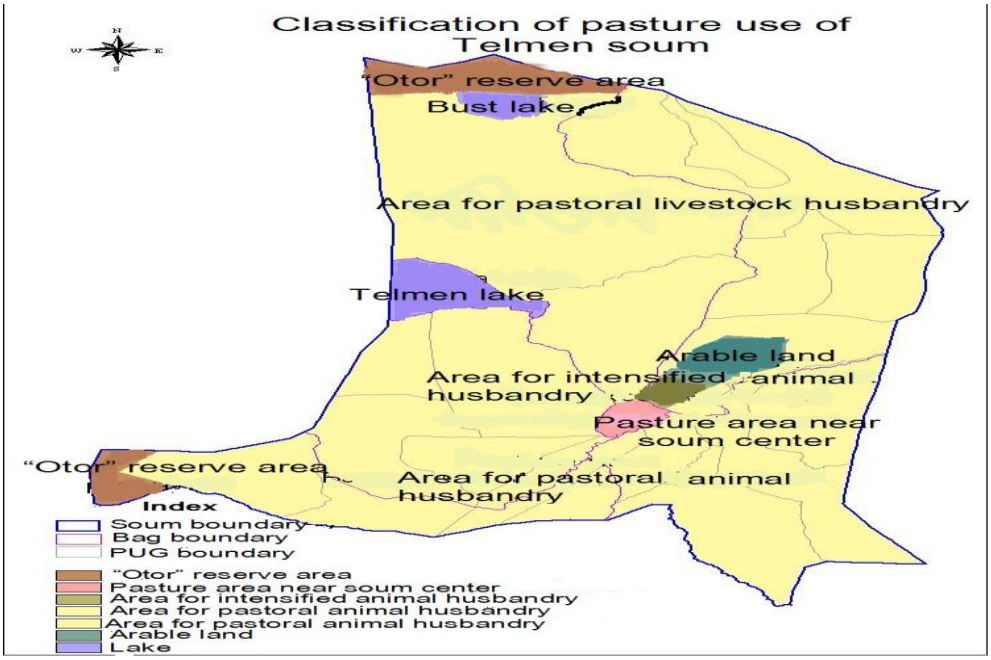
The document "Government Policy on Herders" approved in 2009 supported to develop the structure of civil society for herders' self-helping or self-governing organizations and reflected the basis for creating a condition for establishing national system of herders' self-governing or self-helping institutions.

How to establish the self-governing institution? What is basic principles for establishing herders communities?

The first step of organizing joint activities is the establishment of boundaries of common resources and empowering the right for using this part of pastureland

It is difficult to define boundaries of pastureland in nomadic livestock husbandry that is directly dependent on natural and climate changes. Mobile pastoralists are subject to potentially conflicting needs for **secure resource tenure** on the one hand and **socially and spatially flexible patterns of resuorse use** on the other hand .(Maria.E.Fernandez-Gimenez,2002)

To define boundaries of common resourses it is needed to classify pastureland by its purpose of use (utilization purpose) and establish boundaries of it's classification. It is neede to define the reserve pasture areas and corridors under the Central and Local Government before establishing pasture parsel's boundaries of pastoral herders community . It is providing security for herders to use pasture within the defined pasture parsels on the one side, creating favorable condition for movement of herders (flexibility) from one places to other in disaster situation (drought,zud), one the other side. The pastureland for pastoral nomadic husbandry at the soum level is defined after the establishing boundaries of above (reserve, corridors, intensified farming) mentioned pastureland. All these are creating the better conditions for **secure pastureland tenure for pastoral herders community.**



№	Classification of pastureland of Telmen soum Zavkhan aimag	Area of pastureland	
		Hectare	Percent
1	"Otor" reserve area	13033	4.3
2	Trespassing pasture	805	0.3
3	Pasture area near villages	2414	0.8
4	Area for intensified livestock husbandry	1766	0.6
5	Area for pastoral livestock husbandry	284402	94.0
	Total	302420	100

Pastureland for pastoral, nomadic livestock husbandry should be divided into pasture use units (parsels) and boundaries are be defined on the basis of herders' participation and proposals. **This fuzzy boundaries of pasture parcels for pastoral husbandry system are defined according to the traditional movement pattern and specificity of different ecological regions.** This is providing more flexibility and maintaining the pastoral livestock husbandry system in Mongolia. Within the this pasture parcels boundaries should be define the boundaries of winter and spring pasture area for the individual herders household. Because, winter pasture is more limiting factors for restricting and regulating number of animals. The survival of animals depends on the carrying capacity of winter and spring pasture.

Defining boundaries of pasture parcels and winter pasture leads to regulate and control the number of animals according to the carrying capacity.It is creating opportunity for tackling open access to the pastureland and for establishing herders community in the pastoral society.

Pasture area of PUG,ha

	Soums	Telmen (Forest steppe area)	Tsengel (High mountain area)	Ikh tamir (High mountain area)	Ondor Shireet (Steppe area)	Olziit (Desert area)	Total for 5 soums
1	For all PUGs	337063	600250	331758	243220	1368864	2881155
2	Average	24076	20008	23697	27024	85554	36072
3	Average pasture area per herder household	921	241	548	755	3644	1222

The next step is to form Pasture User Group (PUG) that is a primary unit of herders communities in rural area. This is a group of people living within the defined boundaries and collectively using common pool resources that allow them to protect their pasture land as a source of livelihood, and regulate movements to adapt to natural and climate changes. Herders living within the boundaries they defined themselves are to become members of a community (groups, sub-groups) not depending on they want to or not. This is not top down decision but it is inevitable necessity to accept the principle of community-based resource utilization. Only on these basis freedom and interest of a individual are realized. Size of PUGs depends on the ecological conditions.

Within the general regulations of User Groups, individuals and sub-groups are organized and get possibility to undertake activities. Such kinds of herders' organizations are inevitably needed from the view of cooperative work, every day relationship, saving time and transport costs, and flexible decision making. **These groups and sub-groups are usually formed through the links of relatives and friends**, and also due to the necessity to work as one team (willingness of herders with few animals to look after livestock of wealthy herders,

willingness of non-experienced herders be supported by experienced ones, to join the individuals with higher organizational and managerial skills, to keep business contacts, joining of individuals who trust each other on the voluntary basis for short and long term activities).

PUG size, by households statements

	Statements	Telmen (Forest steppe area)	Tsengel (High mountain area)	Ikh tamir (High mountain area)	Ondor Shireet (Steppe area)	Olziit (Desert area)	Average of 5 soums
1	Total number of herding households	421	1350	937	304	398	682
2	Average number of households in PUG	**32**	**48**	**67**	**34**	**25**	**41**
3	Number of animals per households	244	146	210	337	290	245
4	Number of animals per 100 hectares by sheep unit	**80**	**139**	**109**	**91**	**15**	**87**

The primary pasture use unit is a territory based Pasture User group (PUG). PUGs are composed of khot ails (labor- production management units) and cooperatives, partnership (business oriented groups). Herders, herder households or khot ails that form PUGs are fully responsible for their labor cooperation and production activities. Many activities such as care for livestock and their health, production of livestock products etc., are to be regulated within the herder groups and khot ails. However, the following collective actions directed to supporting and increasing efficiency and productivity of above mentioned activities should be organized:

By organizing collective actions like pasture management issues, livestock breeding, veterinary services, livestock product marketing, PUGs will create favorable condition for business activities of individuals and will exert direct influence upon herders' interest in growing livestock and increasing their productivity.

Organizing all these economic and business activities in line with protection of nature, ecology and pasture land will create favorable condition for sustainable livelihood of herders. If all these activities would be undertaken separately, for instance, if just support activities on income generation it will lead to destroying nature, environment and pasture land. It would influence in a definite period of times on livestock production negatively causing deterioration of herders' livelihood. These processes repeatedly occurs creating threats to sustainable development of Mongolian nomadic herding system.

V. Conclusion

Solving the open access problem requires a territory-based approach of herder organizations that includes all herders having traditionally grazed in the same territory.

Because seasonal and inter-annual mobility of herders remains essential in most ecological zones of Mongolia, the boundaries of these territories need to be permeable but in an organized way by the herder organizations.

Territory-based pasture user groups (PUGs), and their boundaries can be defined by herders themselves, with the support of professional institutions and the backing of the local government.

These groups, supported by technicians, can produce pasture management plans for their own groups and these plans will be reflected in the soums pasture management plans and maps. This way they have a good chance of being implemented because they emerged from a participatory decision making process led by the pasture user groups themselves

Within their territories, individual allocation of winter camp sites, winter and spring pastures, and regulation of seasonal movements can significantly reduce the open access problems by internalizing incentives to conserve pastureland at either the individual or the small group level.

Territory-based groups also have incentives to improve productivity and reduce risks by both individual and collective actions such as setting aside rest areas and reserve pastures, hay making, fencing, etc.

They need enhanced legal rights and collaboration from local government authorities to enforce the decisions in their pasture management plans.

VI. References

1. Agricultural Sector Development Strategy (2006-2015), UB
2. Avaadorj D, 2000; The soil erosion of Mongolia and some methods to content with the Erosion of soils in Central and Eastern European Countries, in the New Idenpendent States in Central Asian Countries and in Mongolia *by R.Lahmer, N.Dosso European Soil Berau*
3. Avaadorj D. and Baasandorj Ya.,(2006). Physical properties of soil and Bringing herders' assets into full economic and productive use, UNDP/SIDA 2004.
4. Darhiihuu A, O. Lkhagvajav, A. Mels et al. "Self rehabilitation of degraded Mongolian rangeland by grazing enclosure", 2008 XXI International grassland Congress, VIII International Rangeland Congress 2008 Volume I, pp 32;
5. Development Program of Meteorology, hydrology and environment monitoring until 2015, UB 2008
6. Dorligsuren D *at al*, 2008 Changes in livestock number and pasture area of Mongolia XXI International grassland Congress, VIII International Rangeland Congress 2008 Volume II; p 152

7. Dorligsuren D, 2006 Issues of improved pasture management. Proceedings of "Theoritical and Practical Conference on Issues and Challenges of Pasture Management" UB (in Mongolian)
8. Erdenetuya D, 2006 Assessment of pasture land condition by NDVI. Proceedings of "Theoritical and Practical Conference on Issues and Challenges of Pasture Management" UB (in Mongolian)
9. GG Progress Report 2004-2008 (in Mongolian)
10. "Green Gold" Pasture Ecosystem Management Project Report, 2008 (in Mongolian) Green Gold Household survey 2009
11. Gunther Mau, J Chantsallkham, Herder Group Evaluation , A study of herder groups, their present status, and future potential , UNDP, Mongolia, 2006
12. Information of Administration of Land Affairs, Geodesy and Cartography for 1989-2012 (in Mongolian)
13. Information of Ministry of Environment, 1996;
14. Lkhgvajav N, 2006; Decrease of pasture land productivity. Proceedings of "Theoritical and Practical Conference on Issues and Challenges of Pasture Management" UB (in Mongolian)
15. Maria E. Fernandez-Gimenez and David M.Swift, 2003 Strategies for sustainable grazing management in the developing world Proceeding of the VII th International Rangelands Congress 821-831
16. Maria E,Fernandez-Gimenez, Akira Kamimura, Batbuyan B. Implementing Mongolia's Land Law Progress and Issues, A research Project of the Central Asian Legal Exchange, Nagoya University, Japan, 2008
17. Maria E, Fernandez-Gimenez and Barbara Allen-Diaz 2001 Vegetation change along gradients from water sources in three grazed Mongolian ecosystems. *Plant Ecology* 157: 101–118, 2001.
18. Maria E.F.G. and Barbara A.D (1999). Testing a non- equilibrium model of rangeland vegetation dynamics in Mongolia. In Journal of Applied Ecology. 1999,36, 871-885
19. National Statistic Year book of 2010-2012, UB 2012
20. National Statistic Year book, 1990- 2008
21. National Statistic Year book, 2004, 2008
22. Oyuntsetseg Ch "Methods of using some particular pastures in forest steppe zone" Abstract of PhD thesis. UB. 2000 (in Russian)

VIII. Annexs

Annex -1. Unified land territory of Mongolia, by main types / number/

	1. Agricultural land		2. Land of cities, villages and other settlements	3. Land under roads & networks	4. Land with forest resources	5. Land with water resources	6. Land for special needs
	Total	of which: pasture					
1971	143303.4	139908.0	163.4		11353.8	1451.2	139.8
1990	124142.7	124285.0	524.6	239.3	15188.4	1624.6	14692
2000	130541.1	129293.8	416.4	336.9	18292	1667.4	5157.8
2012	115399.9	112744.8	702.0	435.3	14256.5	686.8	24931.1

Unified land territory of Mongolia, by main types / percent /

	1. Agricultural land		2. Land of cities, villages and other settlements	3. Land under roads & networks	4. Land with forest resources	5. Land with water resources	6. Land for special needs
	Total	Of which: pasture					
1971	91.6		0.1	0.0	7.3	0.9	0.1
1990	79.4		0.3	0.2	9.7	1.0	9.4
2000	83.5		0.3	0.2	11.7	1.1	3.3
2012	73.8		0.4	0.3	9.1	0.4	15.9

Annex-2. Surface water in Mongolia, census by years

	Rivers		Springs		Miniaral water		Lakes		Total	
	Total	Dried out	Total	Dried out	Total	Dried out	Total	Dried out	Total	Dried out
2003	5621	702	9600	1484	374	10	4196	760	19791	2956
2007	5128	852	9306	2277	429	60	3747	1181	18610	4370
2011	6646	607	10557	1587	265		3613	486	21081	2680

Country paper: Pakistan

Dr. Faizul Bari,
Project Coordinator, FAO Pakistan

1. Introduction/background

Sustainable Land Management (SLM) is the use of land resources encompassing soil, water, animal and plants for the production of goods to cater for the changing needs of human besides assuring the long term productive potential of these resources and the maintenance of their environmental services and functions. The main elements of the SLM include; maintain or enhance productivity and services; protection of natural resources; interventions to be economically viable and socially acceptable. The sustainability of best practices and approaches is also a key parameter.

Pakistan inhabits more than 180 million people with annual population growth of 2.6 percent. This fast growing population has put tremendous pressure on the existing natural resources in terms of food production, cash crops, water, animal rearing, timber, fuel-wood, fodder and other non-timber forest products especially medical plants. The key functions and services provided by these natural resources include water flow regulation, protection of critical watershed, biodiversity, environment, and support to the local livelihoods. However over time, there is a downward trend in the potential productive capacity of these lands and corresponding decrease in the functions and services, which have major implication on the livelihoods of millions of people. The increased population pressure coupled with continuous mismanagement of the natural resources and the climate changes has degraded the natural resources especially land, water and vegetation.

The main causes of the land degradation in Pakistan include poor irrigation and drainage system, intensification of agriculture, removal of vegetation cover (deforestation), overgrazing, increased competition for water, drought, shifting cultivation, frequent flooding, population pressure and above all the high level of poverty. According to estimates; out of the total area of 79.6 million ha of Pakistan, only 20 million ha are suitable for agriculture. This includes 16 million ha irrigated and the remaining million 4 million ha is rainfed. Out of this 11 million ha has been affected by water logging, and 3 million ha has developed salinity. This has a high repercussion on the crop yield. The forestry resource is also very limited and only 5.2 percent land is under forest cover with a total area of 4.2 million ha. The forest area is declining at 27000 ha every year, and the deforestation affects 11 million ha area. Desertification is another phenomenon which is affecting rainfed agriculture and rangelands of 24 million ha. The total pasture area in different parts of Pakistan is 52.2 million hectares constituting 51 percent area of Pakistan.

This downward trend in the natural resource management has the repercussion on the food security and livelihoods of millions of people. In order to cope with this situation, there is urgent need to analyze the current situation, identify the barriers to sustainable land management, and initiate best practices for ensuring sustainable land management. This paper will focus on these parameters and will suggest a number of recommendations for sustainable land management in Pakistan. The country paper will also contribute to Regional Action Programme formulation.

2. Situation analysis at country level

Pakistan is an agriculture based country, where more than 70% of the population is rural and their food security and livelihoods largely depend upon the various products and services

from the natural resources. Mismanagement of these resources is also a key factor for degradation. Over the last 50 years there is an obvious trend of increase degradation of the land resources. The climatic change is another key factor leading to desertification, landslides, and floods and accelerated soil erosion.

Fig 1: The degraded watersheds has lost it productivity and key functions

Figure 2: Riverine floods destroy productive agriculture lands in down stream

Pakistan has the one of the largest canal irrigation systems in the world, however out of the total agriculture land of 20 million ha, 11 million ha is waterlogged and due improper management of the huge irrigation and drainage system. Similarly around 3 million ha has also been affected by salinity. The water logging and salinity have negative repercussion on the drainage capacity of the soil leading to low soil fertility, decline in crop yield and loss of bio-diversity.

Agriculture

Irrigated agriculture mainly depends on the canal irrigation system, which is fed from the water coming from the catchments and temporary stored in the dams. However due to the high rate of deforestation in the catchment areas there is increased surface runoff associated with increased soil erosion. The eroded soil is deposited in the irrigation system as well as in the dams, thus reducing the water holding capacity of these dams, which are the backbone for agriculture in the country. Similarly due to the lack of vegetation cover, the water infiltration is low and the surface runoff is more, resulting into flash floods destroying productive agriculture land in the downstream as well as other basic assts and infrastructures. The 2010, 2011, and 2012 floods are the example of the high runoff and low infiltration. Only 2010 flood damaged around 2 million ha of agriculture land.

On the rainfed agriculture land, due to continuous drought over a spell of 6 years (1997-2003) desertification has increased, where the whole desert ecosystem has been degraded in terms of productivity, biodiversity and the key services and functions. A large portion of agriculture land has been marginalized to a level, which prohibits practicing agriculture due to high investment and low return. In this way, the pressure has shifted to adjacent areas, which are also degraded over time. The desertification has badly affected the food security and livelihoods of millions of poor and vulnerable people living on this resource.

Figure 3: Low vegetation cover leads to flash floods destroying agriculture lands

Figure 4: 2010 floods destroy million acres of land and standing crops

Due to the increased population pressure and limited agriculture land, there is a growing trend for intensification of agriculture. The increased demand for commercial agriculture by growing cash crop has led to monoculture and excessive use of fertilizer and pesticides. This has negative impact on the ecosystem and in long run would deplete the soil, as crop rotation is not possible in case of monoculture. The result is the loss of local sustainable production system as well as the mark reduction in highly valuable crop varieties.

Forestry

The total area of Pakistan is 87980000 hectares, while the forest area is 4,570,000 hectares, which is 5.2 percent of the total area. These forests provide a variety of products and services besides performing certain key functions. . However in last few decades the population pressure has increased to a level, where these forests could not sustainably meet the high demand for timber, fuel, fodder and other non-timber forest products. The high population pressure coupled with the mismanagement has led to the deterioration of the nature resource base. The forest area is declining at 27000 ha every year, and the deforestation affects 11 million ha .The high rate of deforestation in the critical catchments in the upland has increased the runoff and soil erosion and heavy sediment loads destroy the agriculture lands, irrigation systems and the costly dams.

The deforested areas are subjected to high rainfall and soil erosion takes away the top fertile soil. Continued soil erosion on these areas has degraded the land and their productive and protective capacity and function has tremendously reduced. This phenomenon has serious repercussion on the environment, biodiversity and local livelihoods.

Fig 5: Conversion of forests for agriculture lead to the accelerated soil erosion and landslides

Fig 6: increased sedimentation in dams has reduced its life by 50%

In the upland there is also the phenomenon of clearing the forest land for agriculture especially for growing high value off-season vegetables. These lands can support vegetable cultivation for a few years, but later on the top fertile soil is washed away and the land is subjected to accelerated soil erosion and degradation. The high sedimentation rates have also implication for the low land as well, where the big dams are silted up at faster rate reducing the expected life of these costly structures. Similarly it can result in heavy floods. These heavy floods have been experienced in 2010, 2011, and 2012 floods which destroy lot of assets and affected million of poor and vulnerable households.

Rangelands

Rangelands constitute about 51% of the total area of Pakistan, and therefore it is an important component of the natural resource base. It is contributing to the ecological stability to some of the important ecosystems of the country. By definition, Rangelands are those areas, which by reasons of physical limitations, i.e. low and erratic participation, rough topography; poor drainage or cold temperatures are unsuited to cultivation. These are a source of forage for free ranging, native and domestic animals, as well as a source of wood products, water and wildlife. The total pasture area in different parts of Pakistan is 52.2 million hectares constituting 51 percent area of Pakistan. According to an estimate, over a period of ten years the rangelands have declined about 5 million ha. Though the resource is huge, but due to misuse and centuries of overgrazing, the productivity of rangelands has been adversely affected. FAO (1987) has reported a critical stocking rate of 16 ha/animal unit for low potential ranges.

Fig 7: Overgrazing is a major problem in alpine pastures

Fig 8: Overstocking and overuse of the range resource has degraded rangelands in Balochistan

According to the livestock census 2008-09, the total number of livestock in the country was in the tune of 154.7 million, including 33 million cattle, 29.9 million buffaloes, 27.4 million sheep, 58.3 million goats, 1.0 million camels, 0.4 million horses, 0.2 million mules, and 4.4 million asses in Pakistan.

Due to the large number of animals, and its close links with the livelihoods, the livestock sector has emerged as a leading sub-sector of the agriculture sector in Pakistan. It contributed over 11.3 percent to the national GDP during 2008-09. Livestock production is one of the major activities as it engages about 30-35 million people in rearing livestock in the rural areas, who derive around 30-40 percent of their income. In this case, rangelands contribute to provide forage to the livestock in various ecological zones, throughout the country. Rangelands play a significant role by providing livelihood to the poor and

disadvantaged people by supporting livestock, besides their key role in enhancing the infiltration process, leading to sustainable water flow in the down streams.

These pastures and rangelands are situated in fragile ecosystem, where the habitat is under heavy grazing pressure and over time the productivity and bio-diversity has declined. The negative impact of the mismanagement is evident in the form of accelerated erosion and land degradation, besides an overall reduction in the productivity level. Most of these lands are communal and therefore management decisions lie with the whole community. Other major problems in the pasture management are; land tenure; overgrazing, non-uniform grazing, free access to the surrounding forests, accelerated erosion, and weed, while the major social issue is the non-equitable distribution of benefits, as there is no restriction on the number of the livestock. However, the proportion of the northern productive pastures is less than the ranges falling in the arid and semi-arid ecological zones.

By analyzing the base lines it is obvious that the range resources are at decline in respect of its species composition, biodiversity, foliar cover, soil stability, palatability and productivity. The main factors for this decline are the increase in human and livestock population leading towards overgrazing of the range resources. Secondly the climate change and other biotic factors are also instrumental in the poor range condition and downward trend.

The overgrazing initially results in the consumption of more palatable forage species, and at a later stage in the absence of more palatable species consume some non-palatable species as well. Over time, this practice results in a significant change in the species composition. The proportion of the non-palatable species and those species which can resist grazing pressure tend to increase, resulting in non-availability of quality feed for livestock and wildlife. This forces these animals to move to other nearby pastures and in some case to the adjacent forests. In this way, the size of the grazing areas increase, but productivity decreases. In a number of studies conducted in various ecological zones, it can be concluded that the foliar cover has decreased by more than 30% and the current productivity of the ranges is 20-50% of their potential.

Overgrazing is also responsible for the spread of weed and toxic plants, which also pose threat to the animal health. In the high rainfall, alpine and temperate ranges, it was observed that in some cases, more than 27% of the total pasture lands were occupied by the weed and toxic species.

The overgrazing also reduces the foliar cover of the range vegetation, and exposes the soil to high level erosion rates. In the high rainfall ranges, the top soil is washed away, and only rocks and stone bed is exposed, which cannot support vegetative growth. In these areas, rainfall also causes landslides.

In areas with low and erratic rainfall, the range response differently to the amount of rainfall they receive and the time of the year, the rainfall occurs. In these areas, the people whole dependency is on the rearing of livestock. In this way, the number of livestock or the stocking rate is higher than the potential of a given range. The situation is further complicated due to high seasonal and year to year fluctuations in the quantity of the rainfall. In the year of low rainfall, there is corresponding decrease in the forage production, and if the livestock number is kept the same, overgrazing will take place, resulting in a decline in

range trend. In addition to the seasonal variations in the rainfall, the arid and semi-arid ranges also experience prolonged drought, which leads to the desertification of the ranges. In the absence of well-defined coping mechanism the resource loses its productive capacity in terms of species composition and overall production.

In summary, the overall negative factors responsible for the deterioration of the ranges result into the decline and deterioration of the range ecosystem, livestock production, wildlife, and associated functions like the protection of site from soil erosion, water regulation and the opportunity for using the range sites for eco-tourism. All these contribute negatively to the local livelihoods.

3. Major resource degradation problems:

Pakistan is largely an arid and semiarid country with 11 climatic zones. The land degradation varies from zone to zone with specific causes and barrier to sustainable land development. The Northern part of the country is bestowed with natural coniferous forests and alpine and sub-alpine pastures providing various products and services to the local community as well as to the whole country. Due to the steep slopes, high rainfall and population pressure, these ecosystems are fragile and are susceptible to high surface runoff and accelerated erosion and landslides. Deforestation and overgrazing is mainly responsible for land degradation. According to estimation around 27000 ha of forests are depleted each year. The deforestation is also a major problem for flash floods, high runoff, and imbalance flow of water to the downstream and plains, which are the food basket of the country. Similarly the increased number of livestock on the pasture is beyond the carrying capacity, which has led to 50% reduction in the overall productivity of the rangelands besides contributing to the high runoff and sedimentation. The major causes of land degradation problem are the high population pressure, in-appropriate land use, land tenure, shifting cultivation, increased number of livestock and mismanagement.

On irrigated agriculture land, the major significant type of degradation problem is water logging and salinity. A huge chuck of land in the tune of 11 million ha has been affected by the water logging and around 4 million ha of irrigated land has been affected by salinity. The degradation of this huge land has a direct negative impact on the total crop production leading to food insecurity both at household and national level, and reduction in the employment opportunities for the local people. The low agriculture production also affects the overall performance of the agriculture sector to the GDP. According to GOP, 2005 agriculture contributes about 25 percent to the National GDP, however due to the agriculture land degradation this target is difficult to maintain or enhance. The major causes of the water logging and salinity is the poor and in-efficient irrigation and drainage systems, the types of crop grown and the crop management practices.

On rain-fed agriculture land of around 4 million ha, there is a problem of sever and prolonged drought. The crop production in these areas mainly depends upon moisture availability through the sporadic rainfall. In these areas due to the prolonged drought (1997-2003) and continuous mismanagement, desertification is a prominent phenomenon. The result is the degradation of both the land, and the related crops. The changed weather pattern and climate change are also contributing to the problem. Due to the lack of vegetation cover, the torrential rainfall fall results in the flash floods and destroy the agriculture lands and other assets. The current resilience level of the inhabitants of these areas is much lower to cope with the changed situation.

In the whole country in general and the dry areas particular the vulnerability of the poor

people to the environmental shocks such as flood and drought threatens their livelihoods and increase pressure on the natural resources. This situation has put two-third population of the country at high risk in terms of food security and livelihoods. In order to continuously monitor the weather pattern, there is a need of a good early warning system to timely inform the vulnerable communities to better prepared. In face of the increased temperature and low rainfall due to the climate change, there is a big challenge for the agriculture researchers to identify crop varieties which would sustain the drought condition. The major causes of this type of degradation are the change in the weather pattern, over-exploitation of the resource and the in-appropriate land use land tenure system, and in-appropriate agriculture practices. Above all, there is lack of awareness on the part of the local community and other key stakeholders about the desertification and related land degradation.

4. Climate change and role of climate change:

In Pakistan the impact of the change weather pattern due to climate change is obvious in the light of the last three years floods, which has done huge losses to the agriculture and related sectors in terms of land degradation, crop and livestock losses. According to estimates there will be 1-5 degree centigrade increase in temperature by the year 2080. Similarly the rainfall pattern will also change.

Climate change in Pakistan will affect water, food and energy sectors. All the sectors are closely interlinked. According to the World Bank (2006) due to increase population pressure overtime, the water availability has reduced to 1100 cubic meters per person per year in 2010. Prediction indicates that this will further decrease to 800 cubic meters per person/year by 2026. This put Pakistan in the list of water scarce country. The World Bank also predicts the western Himalayan glaciers will retreat for the next 50 years, which will initially increase the flows in the Indus, but overtime once the reservoirs are empty, the flows into the Indus river system will decrease around 30-40%. This will have major implication on the total water availability, and the agriculture sector will suffer the most.

According to estimates in Pakistan about 90% of the fresh water resource is utilized for agriculture crop production. Due to the climate change and the water scarcity will further increased leading to low agriculture production. This reduced production will put the already food insecure people around 60-77 million in more problem, while at the same time the percentage will also raise.

According to one study, the climate change will result in increase in temperature which will put the dry and sub-dray areas under more pressure and desertification will reach to an alarming irreversible rate. It is worth-mention that the main staple food, the wheat is grown in arid and sub-arid zones producing around 90% of the total wheat in the country. With the less water availability and high temperature (short growing season) the wheat production will tremendously reduced. In this case, the country will face the food in-security issues at both household and national level. However, the increase of temperature in alpine and sub-alpine regions, the rangelands productivity will increase due to the longer growing season. The natural resources in general and the pasture resources in particular are subjected to number of adverse factors, which on one hand affect the pasture/range productivity and livestock production ,while on the other hand result into degraded and less productive rangeland ecosystem with marked reduction in the related functions and services. This decline is contributable to a number of factors including climate change, natural and anthropogenic factors including land use changes.

In Pakistan, majority of the rangelands are located in arid and semi-arid ecosystems, where due to the climate changes desertification is an obvious phenomenon. The high temperature and low erratic rainfall (200-500 mm) creates un-conducive conditions for the plant growth. This situation is further deteriorated due to overgrazing. The species composition changes as a result of overgrazing. Over time, only those species would survive which due to their low palatability, deep root system, and production of abundant seeds are hardier us compared to palatable species, which gradually decline and disappear. This phenomenon will force the livestock into two options; first to graze the less palatable fodder species and secondly to move to other areas, where palatable and nutritious forage species are available. In doing so, the extent of the rangeland area will increase, but the productivity will reduce. Generally, such situation occurs in alpine and sub-alpine pastures of the country, where these are accessed and surrounded by forests. In this case, the reduction of productivity due to the mismanagement has strong repercussions on the forest resources.

In order to see, the impacts of climate change on the rangeland ecosystems and productivity aspects, clear understanding about the mechanism is necessary. Climate change is a global phenomenon, where the earth is warming up. With increase in temperature the rainfall patterns also change. Though this situation is more pronounced and predictable at global level, at regional and local levels the situation is more complicated.

Hennessy et.al (2007) reported that the climate change is likely to exacerbate existing pastoral management challenges such as decline in pasture productivity, reduced forage quality, livestock heat stress, greater problems with some pests, diseases and weeds, more frequent drought, more intense rainfall events and greater risks of soil erosion. Similarly Hall et.al 1998 indicated that most important impact of the climate change on rangelands will likely be through changes in both pasture productivity, and forage quality. However there are several other impacts on rangelands that the manger will have to address including botanical changes in vegetation compositions, pest, disease and weeds; soil erosion and animal husbandry. It is therefore necessary to consider how climate change will affect each of these components of rangeland management.

K.M. Siddiqui et al, 1999 conducted a study to determine the impacts of the climate change on natural forest ecosystem of Pakistan assuming a 0.3^0 C rise in temperature and precipitation change of 0, +1 and -1 decade with 1990 as the base year. The current atmospheric CO2 concentration of 350 ppmv was assumed to increase to 425 ppmv in 2020, 500 ppmv in 2050 and 557 ppm in 2080. The BIOME3 model was used for computer simulation of 9 prominent bio-mass types. Of these, three biomass (alpine tundra, grassland/arid wood land and deserts) showed a reduction in their area and five biomass (cold conifer/ mixed woodland, cold conifer/mixed forests, temperate conifer/mixed forests, warm conifer/mixed forests, and steppe/arid shrub lands) showed an increase in their area as a result of climate change. It was further noticed that enhanced CO_2 concentration in the atmosphere appeared to have pronounced effect on the bio-mass area.

The study model also predicted that the net primary productivity exhibited an increase in all biomass and scenarios. However, there is a possibility of forest dieback occurring and of time lag before the dominant plant types have enough time to adjust to changed climate and migrate to new sites. In the intervening period, they would be vulnerable to

environmental and socio-economic disturbances including deforestation, soil erosion, and land use changes. Thus the overall impact climate change on the forests/range ecosystem of Pakistan could be negative. This would require a number of adaptation strategies to cope with climate change impacts on the forests and rangelands ecosystem.

In order to address the negative impacts of the climate change, there is need to have timely availability of data, based on which proper prediction and modeling is done. In Pakistan this information is much lacking and therefore there is a need to establish data base for the climate change and in this regard a number of institutions have to be strengthened.

5. **Barriers to adoption of soil and water conservation (SWC**):

In Pakistan there are a number of key barriers to the adoption of soil and water conservation. These barriers are at various levels and encompass the following main categories; Policy barriers, Institutional barriers, Socio-economic barriers, and the non-availability of timely and appropriate information. The policy barrier comprised of lack of appropriate policy, irrational subsidies on the use of electricity, and limited land use planning. Majority of the communal land is faced with desertification, but due to the lack of appropriate policy and strategy for the sustainable management of these lands, the land degradation process is continuing at alarming rate. Similarly the flat rate for the electricity has encouraged big farmers to install tube-wells, and run these at low subsidized electricity. This has resulted in the over-exploitation of the ground water and resultantly less water is available to those farmers who cannot afford to have tube-wells. In a number of cases like Quetta and Zirat valleys of Balochistan the over-exploitation of ground water and low recharging of soil, the water table has gone down and a number of tube-wells are in-effective and the fruit orchards are drying up, and the farmers both big and small are facing major problems of losing their cash sources of income from the sale of vegetables and fruits. Another major problem is related to the low attention to the land use planning. Similarly no digitized data is available for land use planning. And resultantly productive agriculture lands are converted into housing construction, forest land is converted to agriculture and so on. This phenomenon of shifting cultivation is common in the fragile up-land watersheds. This in-appropriate land use lead to the land degradation.

Among the Institutional barriers the key elements include poor institutional capacities and coordination mechanism, where various related sub-sector of agriculture are managed by specific line departments in complete isolation and thus ignoring inter-sectoral linkages and common areas for holistic natural resource management. Knowledge gap is another area, where very little information is available for rehabilitation of degraded ecosystem, sustainable agriculture and livestock in the context of climate change. The lack of awareness amongst the general public, and policy makers about the land degradation and its implication on environments, food security and livelihoods is another hurdle. The non-mainstreaming of the National Action Plan in the sectoral polices and plans are also negatively affecting the sustainable land use planning and subsequent interventions.

The main financial barrier is the low allocation of the annual budget for the rehabilitation of degraded ecosystems including critical watersheds and other important areas. The main reason for this low allocation is due to the less importance to the sustainable land management by the policy makers. Only recently special budget allocation has been made by the Federal Government in this regard.

The other important category of the barrier is the socio-economic barriers encompassing the vulnerability of the poor people of disaster prone areas, whose resilience low is too low

to cope with any potential disasters may be flood or drought. The other major issue is the current land tenure system which due to the ambiguity leads to the over-exploitation of the resources. Some of the categories of forests (protected forests) and rangelands are example of such lands. The sustainable land management will require clear ownership and clear rights and responsibilities of the key stakeholders.

Above all, the non-availability of timely and reliable data base and information is a also a major bottleneck. The Land Degradation Assessment in Dry Areas (LADA) will be a good tool for collecting this baseline information.

6. Best/appropriate management practices

Pakistan being a disaster prone country has experienced a number of disasters including 2010, 2011 and 2012 floods, and 1997 prolonged drought. Since then all efforts are being made to put a proper policy, and strategies to combat desertification, protect the critical watersheds and bring innovative agriculture techniques where soil and water conservation is ensured. Some of the best management practices for soil and conservation include; collaborative watershed management, sustainable forest management(participatory management planning, joint forest management, and social forestry) participatory pasture and range management, LADA, improvement of irrigation and drainage system, Farmer Field School, women open schools, agro-forestry and farm forestry, Disaster Risk reduction and mitigation measures including bio-engineering.

These best practices have been applied and adopted upto a certain level in various disaster prone sites. However the large scale replication and adaptation is still a major issue. Over the last 20 years the participatory and holistic natural resource management has gain high priority amongst the different stakeholders. Similarly the multiple land-use concepts are also getting importance, which are used in the natural resource planning. Unlike the past, the forestry resources are now considered to provide various products, services and functions, and the management is not centered on trees.

So in nut shell, good practices are available throughout the country in critical zones both in dry and humid areas, but majority of these are linked with projects and large scale adaptation will require the placement of appropriate policies and strategies coupled with the allocation of sufficient resources.

7. **National action programs on Soil and Water Conservation**:

Water is scarce natural resource in Pakistan, and fresh water availability is always on the top of agenda of the government. Accordingly various five years plans, emphasizing on the increased water for agriculture. The Medium Term Development Framework (MTDF) also focuses on efficient use of water and rehabilitation of critical degraded areas. The UN joint Programme (OPI) also emphasized on the soil and water conservation. Similarly the Joint Porgamme OPII, a lot of focus has been given to the soil and water conservation and the rehabilitation of degraded lands. The Strategic Priority Area 3 is related to the disasters preparedness and resilience building. So both the UN and the Government are developing strategies for soil and water conservation. The national drainage programme is working for the rehabilitation of water courses and improvement of drainage system. The other key programmes are as follows;

- Establishment of a National Centre for drought/environment monitoring and early warning at Islamabad
- Destructing and strengthening of National Agriculture System Balochistan
- National Agriculture Land use plan

- Pilot project for promotion of water conservation through introduction of high efficiency irrigation system in Punjab, Khyber Pakhtunkhwa (KP) and Sindh provinces.
- Preparation of National land use plan
- Rehabilitation of degraded watershed in KP
- Formulation of agriculture policy for KP with major emphasis on soil and water conservation
- Formulation of Rangeland Policy for KP
- Preparation of National Rangeland Policy
- Construction of small dams in KP
- Establishment of Forestry Development Fund(FDF) for rehabilitation of degraded watershed in KP

8. Conclusions/recommendations

Based on the critical situation analysis, certain key conclusions and recommendations are drawn. These would help in mainstreaming the sustainable land management in the sectoral policy and plans for improved ecosystem products, and functions. For the sake of easy understanding, first key conclusions will be drawn and then followed by key recommendations.

Key Conclusions:

1. Land degradation is an active phenomenon in the various agro-ecological zones and cropping system. This put more than 80% of the total land use of Pakistan in deteriorating conditions resulting into negative repercussions on the most vulnerable population in terms of their food security and livelihoods.
2. In addition to the livelihood and food security , the degraded ecosystems is declining in respect of the overall productivity, the various environmental, and biodiversity services and key functions like water flow regulation and sediment control.
3. The negative impact of the climate change is already obvious in the light of current frequent and high magnitude of disaster, including floods and drought.
4. The rehabilitation of the degraded land is a complex issue and required multi-disciplinary participatory and holistic approach.
5. The current level of preparedness for responding to the negative impact of climate change is negligible or very low; therefore the damages and losses in many cases will be irreversible.
6. There is a low level of awareness amongst the general public and policy makers regarding the proper recognition of the land degradation problems, and its associated repercussion.
7. There is a lack of information and knowledge gap about the ongoing degradation process and the capacity for the appropriate response. There is a need of institutionalization of the Land Degradation Assessment in the Dry Area (LADA).
8. The increased population pressure and continued mismanagement put more pressure on the natural resources and thus negatively contributing to the fast deteriorating conditions
9. There are a number of best practices related to the natural resources management and soil and water conservation, but to its project approach and lack of programmatic approach, large scale adoption and replication is limited.
10. The major bottlenecks and barrier in the sustainable land management is the policy, institutional, financial, socio-economic parameters of the vulnerable population and land tenure system.

Key Recommendations:

1. There is an urgent need to collect systematic information about the land degradation, the adoption of LADA approach will be of great help in clear analysis of the main drivers of the degradation factors and processes.
2. Collaborative and holistic natural resources management system approach to be followed to stop the degradation of the land, forest, rangelands and water resources.
3. There is a need to further carry forward the UNDP and GEF initiative on sustainable land management. Similarly the FAO collaborative watershed management approach to be followed.
4. There is a need of awareness raising amongst the general public and policy maker to understand the alarming situation of the land degradation and its negative impact on the food security and livelihoods.
5. There is a need to formulate a comprehensive strategy and policy for degraded land rehabilitation.
6. The strengthening of strong land rehabilitation institutions is a pre-requisite for sustainable land management
7. Proper land use planning and formulation of rules and regulations for its implementation.
8. The climate change is a fact, and necessary preparation in Disaster Risk Reduction would be of great help.
9. Launching of degradation land rehabilitation programme for critical watersheds throughout the country based on sustainable land use principles
10. Capacity building in sustainable land use management at all level.
11. Continuation of irrigation system and drainage improvement programme in all provinces
12. Identification of best land use practices in the light of climate change adaptation.
13. Establish and promote National and Regional networks for experience sharing
14. Periodic consultation for experience sharing amongst the regional countries

9. References reviewed

Akram, M. 1987. Animal feed resources in Pakistan. In: Proceedings of the APO Symposium on Animal Feed Resources. Asian Prod. Organization Tokyo, Japan. AKRSP, 1992. Sustainable Forestry Development Programme

Baig, A.R, M.S. Baig, Q. Ali and C.M.A. Khan. 1985. Agro-ecological zonation of Pothwar. A. Wheat. B. Maize. Pakistan Agricultural Research Council, Islamabad.

Bari, Faizul 1990: Forest Management Plan for Khnapur Forests

Bari, Faizul 1992: Project Document, Kalam Integrated Development Project

Bari, Faizul 2005: Feasibility studies for pilot project sites in Khyber Pakhtunkhwa for UNDP/GEF sustainable Land Management Project

Bari, Faizul 2009: Baseline study on Rangeland Resources of Pakistan

Bari, Faizul 2009: Draft National Rangeland Policy for Pakistan

Bari, Faizul Bari. 2001. Demonstration Trials for Improved Range Management Practices in DKP" in the Upland Rehabilitation and Development Project, Dir Kohistan

Bari, Faizul, 2001. Assessment of the Alpine Pastures and their potential for improvement in Dir-Kohistan

Bari, Faizul, 2002. Biomass Survey of northern areas under mountain area conservation project

Bari, Faizul, 2005. Feasibility study of Shiek Haider Zam area, D.I.Khan for Sustainable Land Management Project

Bari, Faizul, 2006. Assessment of Range condition and trend in Kurram Agency of FATA

Bari, Faizul, M.K. Wood, and L.Murray. 1993. Livestock grazing impacts on infiltration rates in a temperate range of Pakistan. J. Range Manage 46: 367-372

Bari, Faizul, M.K.Wood, and L.Murray. 1995. Livestock grazing impacts on inter-rill erosion in Pakistan. J.Range Manage 48:251-257

Bari, Faizul, Zar Nigar Tayyib, Catherien, and Theo Oltheten, 1995. Report on the mid-term evaluation of Malakand Social Forestry Project

Bari, Faizul. 2001. Study on Nomadic Grazing in Dir Kohistan

Bari, Faizul. 2006,Livelihood improvement for women and marginalized people in Abakhel area of Lakki Marwat

Bari, Faizul. 2006. Participatory Rural Appraisal Report for Vehowa on "Participatory Watershed Management and Livelihood in D.G.Khan Hills Torrents"

Bari, Faizul. 2006. Development of model for Pastoral Support System for Kohistan district

Bari, Faizul. 2006. Pasture Management of Dubiar valley of Kohistan district

Bari, Faizul. 2006. Proceedings of consultative workshop on "Participatory Watershed Management and Livelihood in D.G.Khan Hills Torrents

Bari, Faizul.1989. Livestock Grazing and its impacts on soil, water, and vegetation in a temperate range of Pakistan. PhD Dissertation, New Mexico State University, Las Cruces, USA

Bari, Faizul.2005 Feasibility study of social forestry in Balochistan

Bari, Faizul.2005. Pasture Management Survey of Diamer district, Northern Areas

Bari, Faizul.2006. Pasture Management Plan for Mujgali, Dubair valley district Kohistan

Bozdar, N., Nagy, J. G., Sabir, G. F., and Keating, J. D.H. 1989. Animal raising in highland Balochistan: A socio-economic perspective. Research report. International Center for Agriculture in the Dry Areas.

Dir Kohistan Project, 1995. PC-1 Scheme of Dir-Kohistan Upland Rehabilitation and Development.

Environmental Rehabilitation Project, 1997. Transparency on Terms of Partnership with village organizations, Environmental

ERNP, 1998. Diagnostic Survey Report

ERNP, 1999. Strategy for Natural Resource Management

FAO 2007: Collaborative watershed management project

FAO 2012: Project Document RAHA Project

FAO. 1987. Pakistan's experience in rangeland rehabilitation and improvement. Food and Agriculture Organization of the United Nations. 70pp.

GIZ 2003: Provincial Forestry Resource Inventory (PFRI)

Hakim, Mirza 1996. Status of Rangelands and rangeland development in Paksiatn.

IUCN, 2002. Visit Report on Oxford Expedition Team (Upper Hunza)

Khan, C.H. and Anwar M., 1972 Range management strategy Pakistan. Journal of Forestry

Khan, C.M. Anwar. 1968. Sand dune rehabilitation in Thal. Pakistan. Journal Range Management. 21 :316-321.

MACP, 1999. Project Document

Malakand Social Forestry Project, 1992. Considerations and options for Range Management in Malakand division, Technical Report no 2

Malakand Social Forestry Project, 1992. Fodder species in Malakand, A reference manual.

Malakand Social Forestry Project, 1992.Range Management Programme Assessment, Technical Report No 5, MSFP

Malakand Social Forestry Project, 1994. Range Ecology Follow Up Mission, Working Paper 13,

Mian, M.A. and Sial, M.N. 1986. Geomorphology of Pakistan. International forum on soil taxonomy and agro-technology transfer. Soil survey of Pakistan, Lahore.

Mohammad, Noor. 1989. Rangeland Management in Pakistan. Published by the International Centre for Integrated Mountain Development (ICIMOD) Kathmandu, Nepal. p. 193.

Niino, Yuiji 2013: Presentation on " Options on land management and land use for coping with climate change in South Asia

PARC and FAO, 1996. Fodder Production in Pakistan.

Pieper, R.D. 1978. Measurement techniques for herbaceous and shrubby vegetation. New Mexico State University, Las Cruces, USA

UNDP 2005: Project document: Sustainable land management to combat desertification in Pakistan

UNDP 2005: Sustainable land management project; Annual Progress Report

UNDP/EC project document 2005: Project document Community Based Livelihood Recovery Programme(CBLRP)

Wani, Bashir 2007: National Forest Policy Review, Ministry of Environment, Local Government and Rural Development, Government of Pakistan

Country Paper: Philippines

Confronting a Major Constraint to Food and Livelihood Security and Rural Development

Samuel M. Contreras
Head, Soil Conservation and Management Division
Bureau of Soils and Water Management

I. Introduction

The United Nations Convention to Combat Desertification (UNCCD) emphasized that while the awareness of the global community to climate change and biodiversity loss has dramatically increased since the Rio Summit, the significance of land and soil to humanity remain obscure to many. As a result, the risk to livelihoods emanating from land and soil degradation including watershed degradation does not receive the attention it deserves (UNCCD, 2011). This is also true at the national level where more programs and resources are allocated to address climate change and biodiversity loss. Yet, land and soil are under pressure to produce more through intensification, expansion of area beyond the suitable production zone, and application of more inputs.

The direct physical effects of land degradation include drying up of freshwater resources, increased frequency of drought and water scarcity, and a greater occurrence of flooding due to degraded watersheds, inadequate drainage or poor irrigation practices. Aside from its impacts on food security and rural livelihoods, land degradation has also negative impacts on the water resources availability in terms of quantity, and quality. Sustainable land management (SLM) is the antidote of land degradation. As the UNCCD aims for Zero Net Land Degradation (ZNLD) by 2030 (UNCCD, 2012), it is also essential to highlight the benefits from SLM and the current efforts to promote and implement it to prevent land degradation and secure water for the future generation at the country level. Hence, this paper aims to:

1. Undertake situation analysis at the country level with respect to resources management, major land degradation problems, and climate change scenarios;
2. Review and identify soil and water conservation measures as initiatives to address land degradation and major barriers confronting their implementation; and
3. Present the national action program as an integrated and holistic approach to address land degradation problems.

II. Situation analysis at country level

A. Resources Management Sector

The Philippines is well endowed with natural resources and is known to host many interesting habitats that are biologically diverse and composed of universally unique plant and animals. However, because of complex conditions due to increasing population, stagnation of rural economy, diverse culture, isolated small islands and its geographical setting, various forms, sources and severity of environmental degradation occurred in the last five decades (BSWM, 2010).

The historical trend in natural resources use and agricultural development can be described in terms of significant events and changes from the pre-1960s to 1997 onward. The pre-1960s was considered as the era of extensive agriculture when the country had healthy watersheds and natural forests were still intact. The succeeding

decades i.e. from 1961-1980, witnessed the massive construction of dams for irrigation, power and domestic uses with almost all of the prime agricultural lands provided with irrigation at the end of the decade. There was also the massive watershed deforestation for the generation of cash crops. Thus, the decades were highlighted by policy conflict on natural resources management and infrastructure development.

The decade 1981-1990 can be described as the decade of environmental degradation. Prominent during the period was the massive soil degradation in terms of soil mining and human-induced nutrient deficiency in the lowlands resulting to stagnation of crop yield. There was also the increase in use of marginal lands left by logging, expansion of idle grasslands replacing natural forests, and biodiversity loss due to destruction of habitat.

The next half decade 1991-1996 was the period marked by irrational land use conversion to urban development and industrialization. It was also the period when importation of food products began despite the availability of human and natural resources. River systems and aquifers deteriorated along with irrigation systems established during the last decades.

The succeeding decade beginning 1997 was the era when Philippine agriculture and environment were in transition, the period of self review. The Agriculture and Fishery Modernization Act of 1997 was passed which advocated the establishment of Strategic Development Zones for agriculture and fisheries. The Philippine Clean Water Act of 2004 was promulgated to provide a more comprehensive water quality management in the country. The Climate Change Act was also enacted in 2009 which provided the policy framework to systematically address the growing threats of climate change on community life and its impacts to the environment.

With the current situation, food sufficiency and natural resources management became the priority programs of the government. The Philippine Food Staples Self-Sufficiency 'Road Map was launched in April 2011 with the following strategies:

1. Increase and sustain the gains in production through production interventions and enabling mechanisms;
2. Farm mechanization and reduction of post-harvest losses. Just recently (June 2013), the Agriculture and Fisheries Mechanization Law was enacted by the Philippine Congress;
3. Manage consumption by maintaining per capita rice consumption at 120 kg/capita/year.

On February 24, 2011, the implementation of the National Greening Program (NGP) was declared as the government priority program to reduce poverty; promote food security, environmental sustainability and biodiversity conservation; and climate change mitigation and adaptation. Launched in May 18, 2011, the NGP seeks to plant 1.5 billion seedlings in 1.5 million hectares of public lands nationwide in 6 years from 2011-2016. Areas for planting include forestlands, mangroves and protected areas, ancestral domains, civil and military reservations, urban areas under the greening plan of the Local Government Units (LGU), inactive and abandoned mine sites, and other suitable lands of the public domain.

B. Major Resource Degradation Problems

Land degradation and desertification constitute a persistent decline in the services that healthy land provides, especially for food (UNCCD, 2012). In the Philippines, it is likewise seen as a serious environmental problem. Agricultural practices and economic pressures have severely degraded the agricultural resource base, associated with

accelerated soil erosion, siltation of irrigation systems, flooding, and water pollution (Briones, 2009).

Briones (2009) has also made a review of the agriculture-degradation link and cited previous literature (e.g. Cumming 1999) to explain that degradation occurs through: i) actual removal of the soil, through erosion; ii) changes in the chemical, biological, and physical endowments of the soil, such as nutrient loss, salinization, acidification, and compaction. He added that while erosion is a natural process from the action of water and wind, it can be accelerated by human activity, primarily by land clearing. With other factors equal, steeper land is more erosion prone. Soil "loss" is a location-specific concept; soil eroded from one area is deposited elsewhere, and depending on the deposition site, may still be useful for agriculture. As soil erosion occurs upstream in steeper land, it can cause downstream damages through siltation of reservoirs and river systems that may result to subsequent flooding of low-lying areas around them.

The most common type of land degradation in the Philippines is soil erosion which poses a detrimental effect on soil physico-chemical and biological properties. This makes the land less suitable for crop production or in extreme cases severe erosion may result to total loss of soil productivity. About 45% of the total land area in the Philippines is moderately to severely eroded, triggering the movement of subsistence farmers to marginal lands with the hope of meeting their day-to-day food requirement (BSWM, 2010). Approximately 5.2 million hectares are severely eroded and 8.5 million hectares are moderately eroded resulting to 30-50% reduction in soil productivity and water retention capacity. This situation also predisposes the degraded lands to drought and other water availability problems. Based on a classification by the Global Assessment of Soil Degradation (GLASOD) (Figure 1), about 70% of the country's land area has been degraded with soil erosion as the dominant forms of land degradation (Briones, 2009). The result of the Assessment of Human-induced Soil Degradation in South and Southeast Asia (ASSOD) using Global Soils and Terrain Digital Database (SOTER) for the Philippines is shown in Table 1.

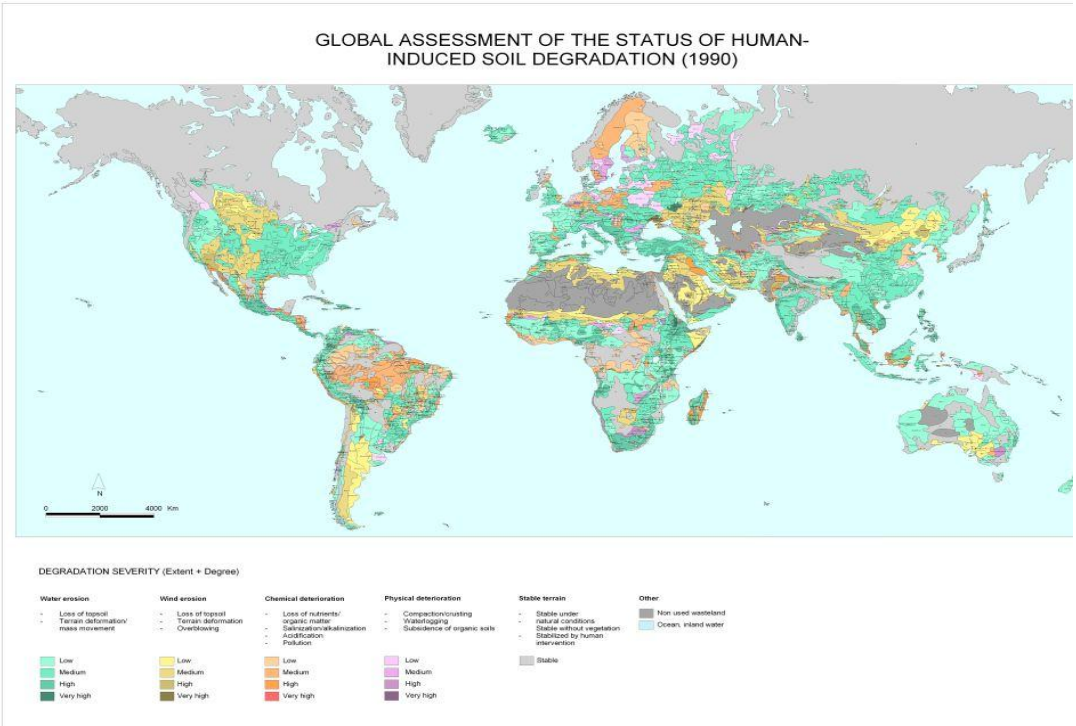


Figure 6. Global Assessment of the status of Human Induced Soil Degradation (1990)

There is a variation in the available statistics on the extent and rate of land degradation due to different definitions and terminology. While these data were generated in the early 1990s, they should be updated using a more standardized methodology. At present, a review and updating of land degradation status using the LADA (Land Degradation Assessment in the Dry Land) methodology is being undertaken by BSWM with the participation of various national government agencies. The LADA methodology is well-described in the World Overview of Conservation Approaches and Technologies (WOCAT) questionnaire on mapping land degradation and sustainable land management (QM).

Table 1. Types of Land Degradation based on SOTER/ASSOD (1993), (BSWM, 2010)

Adminis-trative Region	Total	No Soil Degradation	Top soil erosion	Loss of soil nutrients and/or organic matter	River Erosion	Flooding	Water logging	Urbani-zation, built-up areas and industry	Other Soil Degradation
	10^6 ha	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**	**(%)**
CAR	1.8	10.0	87.0	-	1.6	-	-	0.6	0.8
I	1.2	35.1	46.0	8.7	1.9	0.2	1.4	4.0	2.7
II	2.7	24.4	63.2	6.6	-	-	1.0	1.9	2.9
III	1.8	46.9	34.4	-	1.3	3.9	1.8	5.5	6.2
IV	4.8	60.3	35.0	0.3	-	0.5	-	2.7	1.2
V	1.8	20.1	73.4	-	0.4	6.5	-	-	0.0
VI	2.0	51.5	35.8	10.2	-	0.1	-	1.7	0.3
VII	1.5	20.5	70.3	1.2	-	2.6	-	2.3	3.1
VIII	2.1	46.1	50.0	0.8	-	1.8	-	1.2	0.1
IX	1.6	19.3	76.7	3.2	-	-	-	0.4	0.4
X/Caraga	2.8	12.1	83.3	0.3	0.1	-	0.8	0.4	3.0
XI/Caraga	3.2	10.7	73.5	13.6	-	0.5	-	0.9	0.8
XII	1.5	17.3	76.6	-	-	5.2	-	0.8	0.1
ARMM	1.1	23.7	73.0	-	-	2.6	-	0.5	0.2

Based on the Philippine Updated National Action Plan (2010-2020), the causal factors of land degradation are:

1. Natural causes

    a. Topographic variations and problem soils

    The country is an archipelago with topographic variations in its various islands. It has several mountains and hilly lands which are experiencing decrease in land cover,

thus making them prone to soil erosion. Furthermore, problem soils are dominant in areas with steep slopes, poor drainage, coarse textures, and with fertility limitations;

b. High intensity rainfall and extreme weather events

Because of its geographical location, the Philippines is within the path of about 20 tropical cyclones per year that formed in the Western Northern Pacific. Nearly half of the annual average rainfall of 2,400 mm is brought by these typhoons, which trigger soil erosion in steep slopes being cultivated for agriculture and those idle grasslands that replaced natural forests.

c. Volcanic eruptions.

There are more than 200 volcanoes in the country. One of the major volcanic eruptions was that of Mt. Pinatubo in 1991, emitting enormous amounts of ash-laden steam clouds reaching as high as 20 km above the vent. An estimated 68 billion cubic meter of pyroclastic materials were deposited over a 4,000 square km area, including eight major river basins. The interim effect of this eruption is the occurrence of heavy ash falls and lahar, making vast tracts of lands planted to rice and sugarcane in Central Luzon unfit for agricultural production and, several residential areas unsuitable for human settlements.

2. Human Induced Factors

This is more closely related to the high population growth rate of 1.90 % annually (i.e. with 2000-2010 as the reference period, National Statistics Office), which resulted to increasing requirements for food, clothing, and settlements. To improve crop yield, extensive use of chemical inputs such as inorganic fertilizers, herbicides and pesticides has been popularized which left the soil very acidic and unfit for production in the long run. While the demand for meat and meat products continue to increase, grazing lands for cattle, goat and other ruminants are extensively utilized.

The increasing demand for human settlement and other non-agricultural purposes has contributed to the great loss of prime agricultural lands. This resulted to the opening of ecologically fragile lands. Approximately 74% of the sloping uplands are actively used for subsistence farming in order to augment the demand for food and other basic household requirements.

3. Policy-related Factors

a. Absence of a comprehensive national land use policy and updated land use plans

Inefficiency and improper land utilization can be attributed to the lack of a rational, comprehensive and updated national and local land use plan that will delineate lands for agriculture, biodiversity, human settlements, and industries/commercial centers. Non-delineation of lands resulted to illegal conversions of agricultural lands to non-agricultural lands, displacements of rural communities, and entry of commercial establishment in some ecologically fragile lands.

b. Poor enforcement of land use policies and monitoring of land use conversion:

Boundary between forestlands and alienable and disposable lands are not clearly delineated resulting to complication in enforcement of land use laws and monitoring of land use changes. Illegal logging, shifting cultivation, and encroachment of dwellers in forested areas are rampant. Other effects would

include low land productivity, squatting, and possible establishment of industries, and settlements within ecologically critical areas.

In areas where zonings are in place, zoning ordinances are not strictly implemented partly because of the absence of police power of concerned government agencies in enforcing land use and land conversion laws.

C. Climate Change and its Role

The Philippine National Climate Change Action Plan (2010-2028) highlighted the climate projections done by the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) for 2020 and 2050 (i.e. using a mid-range emissions scenario). The projections indicated that all areas of the Philippines will get warmer, with largest increase in temperatures in the summer months of March, April and May (MAM). Mean temperatures in all areas in the Philippines are expected to rise by 0.9 °C to 1.1 °C in 2020 and by 1.8 °C to 2.2 °C in 2050.

The climate projections further indicate that, generally, there is reduction in rainfall in most parts of the country during the summer (MAM) season. However, there is a likely increase in rainfall during the southwest monsoon season in June, July and August (JJA) until the transition months of September, October and November (SON) in most areas of Luzon and Visayas. Increase in rainfall is also likely during the northeast monsoon months of December, January and February (DJF), particularly in provinces/areas characterized as Type II climate. There is, however, a generally decreasing trend in rainfall in Mindanao, especially by 2050 (PAGASA 2011).

These scenarios thus indicate that the Philippines will not be spared from the impacts of climate change. Even if the world will drastically decrease its greenhouse emissions, stabilizing the greenhouse gases already in the atmosphere will take some time and the impacts of changing climates will continue for years to come. The Philippines, being archipelagic and because of its location, is one of the most vulnerable to these impacts. The country ranked highest in the world in terms of vulnerability to tropical cyclone occurrence and third in terms of people exposed to such seasonal events (CCC, 2011).

D. Best Management Practices

Land degradation is seriously affecting the long term productivity of soil resources primarily through soil erosion and nutrient loss due to unsustainable practices, reduced land cover, and triggered by high magnitude rainfall. As such, major best management practices primarily focus on addressing these problems in form of soil and water conservation measures which include:

i. Rainfed paddy rice terraces. These are terraces supporting rainfed paddy rice on steep mountain slopes: these have been in existence for more than a thousand years. Terraced paddy rice on steep mountain slopes is the main method of rice cultivation in Cordillera Administrative Region (CAR) of the Philippines. This is a traditional technology and most of the terraces are at least a thousand years old. The terraces were constructed manually on steep hill slopes (30-60%) with small portions located in narrow valley bottoms (Source: Technology Database, WOCAT).

ii. Rainwater harvesting through Small Farm Reservoirs (SFRs) and Small Water Impounding Projects (SWIPs) for rainwater and runoff management. With abundant rainfall during the rainy season, direct rainfall and surface runoff are collected and stored for economic uses (i.e. supplemental irrigation, watering

livestock, and domestic purposes) during the dry season. Potential environmental benefits from SWIP include prevention of local flooding and siltation of waterways, groundwater recharging, and creation of habitat for migratory birds.

iii. Sloping Agricultural Land Technology (SALT) refers to a simple, applicable, low-cost method of upland farming which consists of alley farming in which field and perennial crops are grown in bands 4-5 meters wide between contoured rows of leguminous trees and shrubs.

iv. Natural Vegetative Strip **(**NVS) evolved as a variant of Sloping Agricultural Land Technology (SALT), or contour hedgerows, when farmers experimented with the hedgerow concept by placing crop residues along the contour lines and leaving the native weeds to re-vegetate in the unplanted strips, eventually forming stable natural barriers to erosion (Mercado & Garrity 2000).

v. Organic Agriculture - refers to production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation, and science to benefit the shared environment and to promote fair relationship and good quality of life for all involved. It includes the use of crop rotation, compost, and biological pest control to maintain soil productivity and control pests without synthetic pesticides and fertilizers.

vi. Conservation Tillage Technology (Zero Tillage) - A crop production system which focuses on soil conservation and reducing excessive tillage operations, reduces labor and farm inputs while increasing productivity and profitability. It is the practice of planting seeds through the stubble of last season's crop, rather than plowing and disking the field. The stubble protects topsoil against loss to wind and rain and reduces chemical run-off to streams. By not plowing, farmers also conserve soil moisture, which can reduce irrigation demands. Farmers can save fuel by reducing the number of farm machinery passes across their fields (Source: Technology Database, WOCAT).

vii. Residue Incorporation (Corn)- incorporation of corn stalks during land preparation for the succeeding crop. The technology is practiced in corn farm. It involves the incorporation of stalks and leaves, usually chopped, during the land preparation for the succeeding crop. Corn ears are harvested manually. After harvesting, the stalks are cut and spread on the farm. This provides surface protection to the soil during the turn-around period when erosive rainfall events can occur (Source, Technology Database, WOCAT).

viii. Agro-forestry development is an integrated approach of using the interactive benefits from combining trees and shrubs with crops and/or livestock. It combines agriculture and forestry technologies to create more diverse, productive, profitable, healthy, and sustainable land-use systems (Wikipedia). In the Philippines, agro-forestry was advocated as an alternative to the environmentally destructive practice of kaingin-making or slash-and-burn cultivation by many upland farmers. As a strategy of rehabilitating degraded forestlands. It is an attempt to address the twin problems of poverty and environmental degradation. It is a part of people-oriented forestry program through the Integrated Forestry Program in 1982 and has been integrated

under Community-based Forest Management (CBFM) Strategy of government, promulgated in 1995 (Bugayong and Carandang 2003).

III. Barriers in the Adoption and Implementation of Soil and Water Conservation

The adoption of soil and water conservation over the years was relatively slow despite the campaign of concerned national agencies in terms of direct and indirect interventions. Briones (2009) classified direct instruments as those involving the promotion of soil conserving technologies and more sustainable land uses, such as tree and permanent crops establishment while indirect instruments work by altering incentives for the direct instruments, i.e. encourage the adoption of conserving technologies, penalize erosive land use, and so forth. Literature review provides a good account of various soil and water conservation technologies that reduce soil erosion. There were also economic gains in the use of soil conservation measures that were cited in the literature. However, despite these claims, soil conservation strategies remain not widely accepted by farmers due to some issues and concerns. Barriers to adopt soil and water conservation measures could be related to technology itself, tenure insecurity, economic and institutional factors.

A. Technology-related

Technology related factors are due to the cost and input requirement and technical nature of specific soil and water conservation technologies. For instance, according to Gerpacio et al. (2004), hedgerow technology was not sustained due to its intensive labor requirement. High establishment costs are also a major disincentive in adopting this technology (Nelson et al. 1996). Farmers tend to be hesitant to adopt a new technology unless it is successfully adopted by another farmer whose own testimony about its effectiveness particularly on increasing production, is presented to them. Their hesitation can also be attributed to potential risk associated with the technology with respect to its adaptability to the changing climatic pattern and existing environmental conditions. Essentially, increasing climatic risk with respect to a specific technology will affect farmers' decision on soil conservation (Rola et. al. 2006) as the adoption of inappropriate land management practices particularly in sloping lands will do more harm to the environment. As we rely on technologies for increased productivity, sometimes they also open windows for convenience and easy access even of the more fragile ecosystems. Thus, the technologies become inappropriate and not in harmony with the environment. At some points, specific land use does not match with land quality resulting to low productivity and further deterioration of our land resources.

B. Tenure insecurity

In most cases, sloping lands are intensively cultivated for short-season or annual crops where they could immediately obtain the desired production outputs. Tenure security may be seen as a means to encourage farmers to make long term investments in land quality, such as soil conservation or shifting to permanent crops (Briones, 2004). Based on farm household characteristics, Rola et. al. (2006) who studied soil conservation decisions and upland corn productivity noted that tenure of plots among adopters of soil conservation is more secure than non-adopters. This was confirmed by other studies which find that ownership is a positive and significant factor in making decision to adopt soil conservation (e.g. Lapar and Pandey (1999) as cited in Briones, 2009). However, some studies on the Philippine uplands in the 1990s (reported in Cramb et al, 2000) find that tenure is not a significant factor in the adoption of soil conservation technologies for reason that they feel already secure about their informal tenure even without the needed formal tenure instruments (Briones, 2009).

C. Socio-economic factors

Soil erosion is the dominant form of land degradation which generally occurs in the uplands of the Philippines. Comparing with the lowland, coastal and river deltaic zones, the uplands are best described as less densely populated, more dependent on agriculture and other resource-based industries, and their inhabitants are considered as the "poorest of the poor". They are also less educated, marginal, and living in resource poor communities. With such socio-economic conditions of upland dwellers, the adoption of soil conservation technologies that may entail additional resources (i.e. labor, planting materials, and other production inputs) will be difficult for them. Soil conservation technologies, therefore, should be implemented within the socio-economic and bio-physical environments of marginal farmers in the uplands (Mercado et. al., 1999).

D. Institutional factors

It is very important to have an institutional structure that could empower the farming community to adopt soil conservation programs effectively and subsequently disseminate and promote conservation farming including agro-forestry in a sustainable manner. Participatory approaches and partnership arrangement are also needed to meet the aim of promoting sustainable technologies which seem to be inadequate to encourage broader adoption of soil conservation measures and facilitate documentation and sharing of experiences. Extension follow-up is also difficult without the proper institutional arrangement to undertake the process. An institutional innovation for the effective dissemination of conservation farming technology was introduced by the International Center for Research in Agro-forestry (ICRAF) in the mid-1990s. Known as Landcare, it is a movement of farmer-led organizations supported by the local government that share knowledge about sustainable and profitable agriculture on sloping lands while conserving natural resources. It is a method to rapidly and inexpensively diffuse agroforestry practices among upland farmers, based on the farmers' innate interest in learning and sharing knowledge about new technologies that earn more money and conserve natural resources (Garrity and Mercado, 1998). Started in the municipality of Claveria, Misamis Oriental in northern Mindanao, the approach should be promoted in other areas of the country with the Claveria landcare experience as the model for scaling-up and scaling-out.

IV. National Action Program on Soil and Water Conservation

At the national level, the agency with primary responsibility over natural resources management, particularly forest land, is the Department of Environment and Natural Resources (DENR) while the management of soil resources primarily for agricultural purposes falls under the Bureau of Soils and Water Management of the Department of Agriculture (DA). On the other hand, the Local Government Units (LGUs) play an important role in determining the direction of resources use and conservation within their area of jurisdiction.

Presently, the DENR is spearheading the National Greening Program which intends to plant some 1.5 Billion trees covering about 1.5 Million hectares for a period of six (6) years from 2011 to 2016, in lands in the public domain which include forestlands, mangroves and protected areas, ancestral domains, civil and military reservations, urban areas under the greening plan of the Local Government Units (LGU), inactive and abandoned mine sites, and other suitable lands. NGP is beyond reforestation because its mission also covers food security, poverty reduction, environmental stability, biodiversity conservation, and climate change mitigation and adaptation. As an implementation strategy, all government agencies and institutions, including local government units provide full support to the program, not only in terms of tree planting but also in the production of quality seedlings, mobilization of

all government employees, including students from Grade 5 to college level, to plant at least 10 seedlings each annually. The private sector is also encouraged to participate in the program as well. Upland communities are tapped in taking care of the seedlings planted by other participants. In turn, they are included in the Conditional Cash Transfer Program of the Department of Social Welfare and Development (DSWD). As of September 2012, a total of 153,299 hectares were planted which is equivalent to 104,432,459 seedlings planted. About 300,000 hectares is targeted to be planted under the Program.

The DENR through its Protected Area and Wildlife Bureau (PAWB) is also currently implementing a project "Mainstreaming Biodiversity Conservation in Local Agricultural Landscape" otherwise known as the Biodiversity Partnership Project (BPP) as it involves national government agencies, local government units and Civil Society Organizations. Funded by the Global Environment Facility (GEF), the project aims to demonstrate how Local Government Units (LGUs), with enhanced capacities, and working together with local and national partners, can plan and manage economic activities and growth in ways that meet landscape-level biodiversity conservation and sustainable use objectives in critical eco-regions/areas. The project outputs include national-level policy, programs & technical capacity to support biodiversity-friendly agricultural practices which also embrace soil and water conservation technologies being adopted in eight pilot protected areas and Key Biodiversity Areas (KBA) covering at least 700,000 hectares.

Meanwhile, the Department of Agriculture is implementing the National Organic Agriculture Program (NOAP) as mandated under Republic Act 10068 otherwise known as Organic Agriculture Act of 2010. It is targeted that by 2016, 5% (460,000 hectares) of the total agricultural area is converted to organic production. The Philippine National Standard on Organic Agriculture which support the implementation of NOAP, also consider crop production and post-harvest operations as one of the its major components; under it are standards and minimum requirements for crop rotation and soil management practices, and soil and water conservation. The Bureau of Soils and Water Management (BSWM) is implementing rainwater harvesting through small water impounding projects (SWIP) to collect and store rainfall and runoff during rainy season for economic uses during the dry season. As of December 2012, about 479 SWIPs were implemented serving 28,846 hectares. The BSWM is also engaged in the establishment of Soil Conservation Guided Farm Project (SCGFP), a land use management approach that integrates technologies within the socio-economic conditions and bio-physical limitations of upland areas so that our soil and water resources are developed in a more sustainable manner. It involves a farming system that adopts appropriate land use management options and the right mix of soil and water conservation practices. However, at present, there is no dedicated national program on SCGFP such that it is being implemented on request basis in terms of establishing technology demonstration farm.

In essence, there are already good programs that address land degradation problems in the country. In order to put them in proper context, they should be integrated into an officially sanctioned policy on sustainable land management through the alignment of the National Action Plan to combat desertification, land degradation and drought (DLDD) with the UNCCD 10-Year Strategic Plan and Framework or The Strategy. The current Philippine NAP (2010-2020) intends to help reduce poverty and promote environmental sustainability through a strengthened convergence of actions among national government agencies, local government units, academe, and civil society organizations to prevent desertification and land degradation and mitigate the impacts of droughts. It has three (3) thematic programs, namely: Sustainable Agriculture and Natural Resources Based Livelihood Development; Sustainable Use and Management of Vulnerable Highlands, Hilly lands and Lowland Ecosystems; and National Development Platform on Climate Change, Food Security, and Natural Disasters. However, it lacks the Integrated Financing Strategy that will facilitate the implementation of about 25 proposed projects under it.

The synergy of the three Rio Conventions at the country level was pursued through the project "Strengthening Coordination for Effective Environment Management (STREEM)". It thus reactivated and strengthened the Committee on the Conservation and Management of Resources for Development (CCMRD) under the Philippine Council for Sustainable Development (PCSD), which serves as the coordinating mechanism of the three Multi-lateral Environmental Agreements (MEA).

V. Conclusion and Recommendation

Being caused by various factors, land degradation is a complex phenomenon that requires integrated and holistic solutions. The multi-stakeholder nature of land utilization and the lack of a comprehensive land use policy framework have resulted to the continued negative environmental effect on land, aside from confusion due to inconsistent laws on land utilization and the unabated conflicts among different sectors due to competing land use (Senate Economic Planning Office, 2005). In line with this, conflicting land uses and practices, inappropriate land classification and disposition of watershed areas, and unabated encroachment and illegal occupancy within watershed areas are some of the unresolved issues that also threaten watershed resources.

In view of the foregoing discussion, soil and water conservation and management should be examined in the general framework of sustainable development goal that addresses environmental challenges (e.g. climate change, land degradation, bio-diversity loss); attainment of economic targets; and provision of social needs. At the country level, a good review of literature has revealed that there is an abundance of best practices that could be promoted for scaling-up and scaling-out. There are technical innovations to make specific soil and water conservation measures more suitable to prevailing socio-economic and bio-physical conditions. There are also institutional innovations which are not unique or different from the usual principle of community-based approach and partnership among key players. Yet, the implementation of soil and water conservation and its impacts are still way below expectations. Under these circumstances, we need

1. Effective knowledge management and decision support tools for up-scaling and replicating best practices on soil and water conservation;
2. Local policies for mainstreaming soil and water conservation into Local Government Development Plan; and
3. Enabling environment in terms of a unified soil and water-related national policies and programs, institutional arrangements, financing, and incentive mechanisms to broaden the implementation of soil and water conservation. This should be considered in the NAP which is currently being aligned with the 10-year Strategic Plan and Framework of the UNCCD, in the Philippine Development Plan (PDP) particularly in the conservation, protection and rehabilitation of natural resources. Essentially, this will also lay the ground for mainstreaming soil and water conservation into the local development plan of the LGU.

As we seek sustainable development, we must work together to leave a legacy of clean and abundant freshwater, productive soils, and vibrant and resilient ecosystem for the future.

VI. References

Briones, R. M. 2009. Land Degradation and Rehabilitation in the Philippines: The Philippines Country Environmental Analysis.

Briefer on the National Greening Program. http://www.gov.ph/2011/05/18/briefer-on-the-national-greening-program-may-18-2011/. Accessed on August 6, 2013.

Briefer on Food Staples Self-sufficiency Road Map 2011-2016. http://www.gov.ph/2011/04/12/briefer- on-the-food-staples-self-sufficiency-roadmap-2011-2016/. Accessed on August 6, 2013.

Bugayong, L.A., and Carandang, W. M. 2003. Agroforestry practices in a community-based forest management site. http://www.fao.org/docrep/ARTICLE/WFC/XII/0447-B5.HTM. Accessed on August 6, 2013.

Bureau of Soils and Water Management (BSWM). 2010. The Updated Philippine National Action Plan to Combat Desertification Land Degradation and Drought (FY 2010 – 2020).

Climate Change Commission (CCC). 2011. The Philippine National Climate Change Action Plan.

Cramb, R., J. Garcia, R. Gerrits, G. Saguiguit, 2000. Adoption of soil conservation technologies. In: Briones, R. M. 2009. Land Degradation and Rehabilitation in the Philippines: The Philippines Country Environmental Analysis.

Cummings, D., 1999. What is soil degradation? In: Briones, R. M. 2009. Land Degradation and Rehabilitation in the Philippines, The Philippines Country Environmental Analysis.

Gerpacio, R. V., Labios, J. D., Labios, R. V., and E. I. Diangkinay, 2004. Maize in the Philippines: Production Systems, Constraints, and Research Priorities. In: Briones, R. M. 2009. Land Degradation and Rehabilitation in the Philippines: The Philippines Country Environmental Analysis.

Lapar, M. L. A., and S. Pandey, 1999. Adoption of soil conservation: the case of the Philippine uplands. In: In: Briones, R. M. 2009. Land Degradation and Rehabilitation in the Philippines: The Philippines Country Environmental Analysis.

Mercado, A.R., Garrity, D. P., Catacutan, D. 1999. Technical and Institutional Innovations to Conservation Farming and Agroforestry: Component of Sustainable Watershed Management
http://www.worldagroforestry.org/sea/ph/02_pubs/papers/04_tech/techwater.pdf. Accessed on August 6, 2013.

Mercado, A. and Garrity, D.P. 2000. "The Landcare Approach: Enhancing Community Participation in Sustainable Agriculture and Natural Resource Management in the Uplands" In: Catacutan, D.C. and Cramb R.A. Scaling up Soil Conservation Programs: The case of L:and care in the Philippines.

National Statistics Office. Philippine Population as of May 1, 2010. http://www.nso-ncr.ph/HR.html. Accessed on August 12, 2013.

Nelson, R., R. Cramb, and M. Mamicpic, 1996. Costs and returns of hedgerow intercropping and open-field maize farming in the Philippine uplands. In: Briones, R. M. 2009. Land Degradation and Rehabilitation in the Philippines: The Philippines Country Environmental Analysis.

PAGASA .2011. Climate Change in the Philippines. NEDA-MDGF 1656.

Rola, A. C., Sajise, AJ. U., Harder, D. S., Alpuerto, JM. P. 2006. Soil Conservation Decisions and Upland Corn Productivity: A Philippine Case Study. Asian Journal of Agriculture and Development , Vol. 6, No. 2.

Senate Economic Planning Office, 2005. Requisites of a Land Use Policy. Policy Insights. October 2005 Issue, PI-05-05.

UNCCD. 2011. Land and soil in the context of a green economy for sustainable development, food security and poverty eradication.

UNCCD. 2012. Zero Net Land Degradation, A Sustainable Development Goal for Rio +20.

Wikipedia, Definition of Agroforestry: http://en.wikipedia.org/wiki/Agroforestry. Accessed on August 5, 2013.

World Overview of Conservation Approached and Technologies (WOCAT). Technology Database. http://qt.wocat.net/qt_report.php. Accessed on June 24, 2013.

Country Paper: Sri Lanka

E.R.N.Gunawardena
Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka. Email: nimalgun@pdn.ac.lk

Introduction

Sri Lanka is situated in the Indian ocean between latitude 6^0 N and 10^0 N and longitudes 80^0 E and 82^0 E. The physical features of Sri Lanka exhibit a diverse terrain, resulting in very diverse climatic variations within the island's small landmass of 65,610 square kilometers. The country is a multi-ethnic, multi-religious secular state, with a total population of over 20.4 million and a population density of 326 persons per km2. The population in Sri Lanka is still predominantly rural as only about 20% of the population live in urban areas.

Sri Lanka is prosperous in water resources with 103 rivers, more than 20 wetlands, exceptionally designed major and minor irrigation systems and significant ground water resources (MoE, 2008). The per capita water availability is about 2500 m^3, though there are spatial and temporal variations. Rainfall is the only source of precipitation and its uneven distribution is being governed by two monsoons along with the orographic influence of the central mountain region. Some rain occurs as a result of convectional effects from depression and local thunderstorms during transitional period between the monsoons. The annual rainfall varies from about 950 -5000 mm.

Sri Lanka with its tropical climate experiences a higher relative humidity with daytime values often varying between 60%-85%. The nighttime values ranges from 75% to 95% approximately. The mean annual temperature values in Sri Lanka show largely homogenous temperatures in the lowlands and rapidly decreasing temperature in the highlands. In the lowlands (up to an altitude of 100-150 m), the mean annual temperature varies from 26.5^0 C to 28.5^0 C. In the highlands, the temperature falls quickly as the attitude increases, approximately at a rate of 2^0 C every 300m.

The agro-ecological regions are defined in terms of rainfall regime, elevation, terrain and soils. The country is divided into 3 zones based on the annual rainfall, namely Wet zone (rainfall of >1750 mm), Intermediate zone (rainfall of 1250 mm- 1750 mm) and Dry zone (rainfall of <1250 mm). Further divisions are made on elevation, i.e. low Country (<300 m above MSL), mid country ((300 m-900 m) and up country (>900 m above MSL). Further divisions are made according to rainfall, landform and use and soils and altogether, there are 46 agro-ecological regions, as given in Annex 1, and the information is generally used for agricultural planning.

Of the total cultivable land of 1,860,436 ha, paddy occupies nearly 40% of the agricultural land (Table 1). Coconut, tea and rubber together account for 42.5%. The remainder of 17.5% is accounted for all other crops, other field crops, horticultural crops and other export crops. Sri Lanka's agricultural output per hectare or per agricultural worker is significantly lower than that of the neighboring Asian countries. The low level of productivity and over-employment are key issues for this unfavorable outcome.

Recent estimates indicate that 50% and 30% of agricultural lands in Sri Lanka have been degraded due to soil erosion and declining soil fertility respectively (Kenderagama, 2013). If not addressed, this problem would have serious consequences on agriculture sector which contributes to about 13% of the country's GDP and employs about 33% of its work force. This problem of land degradation and its impact on agriculture, food security and resulting

poverty of its workforce will further enhanced by climate change. Therefore, interventions need to be made to address the continued land degradation issues which are likely to aggravate by the climate change impacts. The purpose of this paper is to review the existing problems of land degradation, climate change and bio-diversity and indicate strategies that have already being taken to address the issues at the national level.

Table 1. Land use in Sri Lanka

Type	Agricultural Area		Land area including agriculture	
	Proportion %	Area (ha)	Proportion %	Area (ha)
Paddy	39.8	739,903		
Subsidiary Crops	7.0	131,120		
Coconut	23.9	443,952		
Rubber	8.4	157,100		
Tea	10.2	188,971		
Other export crops	3.4	62,330		
Other food crops	7.4	137,060		
Total Agricultural Land	100.0	1,860,436	28.4	1,860,436
Forests			23.1	1,516,414
Inland Water			4.4	290,500
Other			44.1	2,893,650
Total land area			100.0	6,561,000

(Source: Department of Census and Statistics, 2003)

Situation Analysis

Agricultural sector

As indicated above, the agriculture in Sri Lanka plays a key role in the country's economic development. However, at present, agriculture sector faces a number of problems including low productivity, low level of technological innovation, inadequate credit flows, poor access to international markets and inadequate quality seeds and planting materials.

Being the staple food of Sri Lankan, rice has become the main source for calorie requirement of the people. At present, Sri Lanka is almost self-sufficient in rice (DNP, 2010). The demand for rice is expected to grow faster than the local production due to increase in population and the people's shift from wheat flour to rice on account of government's supportive policies. Therefore, in order to cater to the increasing demand, it is necessary to raise the average yield of paddy significantly. While expanding the cultivable extent through new lands, particularly in the North and the East, the average yield is expected to be increased through cultivation of improved varieties, improved seed production, adoption of advanced water management systems and harvesting techniques. With the approach of self-sufficiency, government is also expected to support the production of more value added products from rice which will be popularized in the local market and then directed to international markets.

The productivity of paddy lands has increased from 2.06 t/ha in 2005 to 4.3 t/ha in 2009 primarily due to increased extent, technological improvement and government policy on fertilizer subsidy (Herath et al, 2013). It is expected to increase the productivity to 5.5 t/ha and 6.5 t/ha by 2015 and 2020 respectively as shown in Annex 2a (DNP, 2010).

Unlike, rice, the country is far from achieving self-sufficiency in Other Field Crops (OFCs). As shown in Annex 2b, nearly 50% of the OFC requirement of the country is imported. However, the OFCs which could be grown locally will be given high priority for further

expansion according to the government policy, primarily through the development of high yielding varieties.

The country has potential to produce all its tropical fruits and vegetable for its needs and also for export (Annex 3c). The policy of the government is to increase the production of these items to attain near self-sufficiency level by 2020 (MFP, 2010). The government is expected to encourage the Small and Medium Entrepreneurs (SMEs) to invest in cultivation by providing necessary inputs (e.g. Land) and creating a conducive environment for investment.

Sri Lanka is being recognized as one of the best quality production centers for floriculture products in the world. The government has an ambitious plan to establish 1500 floriculture villages in the Western, North Western and Central provinces providing 30,000 jobs in rural and sub-urban areas (DNP, 2010).

Plantation crops, mainly tea, rubber and coconut cover 12% of the country's land area. Apart from the major plantation crops, supplementary plantation crops, i.e. cashew, sugar and palmyrah and export agricultural crops also has a potential to grow further. This sector plays a dominant role by providing livelihood and earning foreign exchange. It provides employment to about 1.5 million persons and contributes to 23% to agricultural production. About 20% export earnings are generated by the plantation sector.

The policy thrust of the government in the plantation sector over the next ten years is to increase production and export earnings by 35% to 40% respectively while increasing productivity and profitability of both corporate and small holding sectors on a sustainable basis.

Forestry Sector

Sri Lanka has a total of 1.94 million hectares of forests covering 29.5% of the land area. An extent of 1.47 million hectares or 22.4% of the land area classified as dense forests (over 75% canopy cover) while the balance 0.47 million hectares or 7% of the land area classified as open forests (40%-75% canopy cover). In addition, there are about 90,000 hectares of forest plantations comprising of Teak, Mahogany, Eucalypts, Pine and other local species which accounted for nearly 1% of the land area.

The forestry sector is one of the best planned and managed natural resources sector in Sri Lanka. The first Forestry Sector Master Plan prepared in 1986 made a valuable contribution to improve the database needed for planning and to introduce a systematic approach to develop forest resources. However, the plan did not addressed environmental aspects of forestry adequately while failing to get all the key stakeholders involved in the planning process. In order to address the deficiencies found in the first forestry master plan, the National Conservation Review (NCR) was carried out with the IUCN during the period of 1991-1996 with the main focus on assessing the importance of country's forests for soil, water and biodiversity conservation. All natural forests of 200 hectares or more were included in the NCR, except those in the north and east of the country. A total of 281 forests were evaluated with respect to their importance for soil and water conservation using a novel methodology (Gunawardena, 1995). Based on the recommendations of this review, the current master plan was prepared in 1995 covering bio-physical, environmental, socio-political, and economic aspects of the forestry sector. The plan covers the period 1995-2020.

The Forestry Sector Master Plan puts particular emphasis on, conserving the remaining natural forests to maintain biological resources (flora & fauna) as reservoirs of biodiversity, empowering people and rural communities to manage and protect multiple use forests mainly for their own benefit, building partnerships in forestry development activities,

developing home garden and other agro forestry systems as well as forest plantations to meet peoples' basic needs and to supply industrial wood, policy and legal reforms and developing and strengthening forestry institutions, both state and NGOs.

As shown in Annex 3, the forestry sector has fairly stabilized. The degradation of forest areas has gradually decreased over the years. The extent of plantation forestry has not significantly increased over the last 10 years. The forest department, as at present is, maintaining its stock by implementing routing management plans since there is a serious constraint of land availability and funding for reforestation.

However, there are different types of tree resources outside the traditional forest areas. Home gardens, Coconut plantations, Rubber plantations, shade trees in Tea plantations, roadside plantations, trees in farmlands and other perennial plantations provide majority of the industrial timber (more than 70%) and bio fuel (more than 80%) demand of the country. Home gardens perhaps are the best developed agroforestry system in Sri Lanka. This system of perennial cropping has been practiced for several centuries in the country. It is essentially a system of mixed cropping with a variety of tree species that provide food, fruits, timber, medicine, and spices. Home gardens are widespread in the country and vary in species composition and tree density. Home gardens produce around 42% of the industrial timber and 27% of bio fuel requirement of the country. Home garden sector is thus promoted in almost all recently implemented natural resources sector development projects due to the above reasons in addition to food security.

Major Resource Degradation Problems

There is evidence that sound watershed management practices existed in Sri Lanka before the colonial period which began in the early 1800s. The central hills, from where all Sri Lanka's major rivers originate, were under natural forest cover whilst the valleys were under agricultural production watered by an intricate system of irrigation reservoirs and canals. The degradation of watershed resources began with the large scale clearing of the central highlands for plantation crops in the latter part of the nineteenth century. Removal of forest cover and the associated soil erosion were the main problems identified by scientists as far back as 1883.

The removal of forest cover exposes the soil to erosion and compaction. Reduced vegetation cover allows more water to reach the soil more rapidly. Less infiltration caused by surface sealing and compaction increases surface runoff and hence erosion which reduced the depth of soil and its capacity to store water. For example, an average of 300 mm of top soil has been lost from Sri Lanka's upper Mahaweli Watershed during the last century (Krishnaraja, 1982), thereby reducing the capacity of soil to store water by about 60 mm. With increasing surface runoff, the ground water is progressively lowered and process of desertification set in. Steep hill sides become more prone to landslides, perennial streams become ephemeral, and flood more frequent with increased surface runoff and accumulating sediments in river beds. Invariably, the repercussions of increased sediment loads and higher flood peaks are experienced kilometers down streams from deforested headwaters. In the long term, sedimentation of reservoirs reduces their capacity to store water for hydropower and irrigation, jeopardizing the agro-industrial base of the economy.

The extent of land subjected to soil erosion in each of 24 districts of Sri Lanka is given in Table 2. Haphazard gem mining, cultivation, lack of adequate land management practices in agricultural lands, deforestation and inadequate land use planning are also causes of human induced soil erosion in the country. Chena or slash and burning cultivation is also a major problem affecting land degradation in the Dry Zone.

Table 2. Estimated extent of land subjected to soil erosion

District	Percentage of Land Area	District	Percentage of Land Area	District	Percentage of Land Area
Colombo	2.3	Jaffna	22.7	Ampara	38.9
Gampaha	2.4	Matara	24.4	Kandy	41.0
Killinochchi	8.0	Kurunegala	26.5	Ratnapura	42.0
Kalutara	11.1	Vavuniya	28.2	Monaragala	42.5
Mullativu	14.6	Puttalam	28.6	Hambantota	42.8
Mannar	17.1	Polonnaruwa	28.7	Badulla	54.8
Kegalle	17.3	Batticaloa	30.9	Trincomalee	55.0
Galle	20.6	Matale	38.1	Nuwara Eliya	58.0

(Source: Nayakakorala, 1996)

The extent of land subjected to soil erosion does not necessarily indicate the priority of interventions in terms of erosion control. This is because the importance of soil erosion impacts are decided by the location of major headwaters of rivers, multipurpose reservoir systems which stores water for hydropower, irrigation and water supply, the presence of plantation sector and the erosion hazard which depends on steepness of land and intensive rainfall. In this respect, the central province is the most important province in terms of soil erosion. The soil erosion hazard of three districts of the central province is given in Table 3.

Table 3. Extent under each soil erosion hazard class within the Central Province of Sri Lanka

Soil erosion hazard class	Nuwara Eliya District		Kandy District		Matale District	
	Extent (ha)	%	Extent (ha)	%	Extent (ha)	%
Low	49610	29	46792	25	94500	47
Moderate	53635	31	54618	29	75929	37.4
High	28185	17	36171	19	12450	6.2
Very High	32890	19	47790	25	18900	9.3
Extremely High	6255	4	3790	2	160	0.1
Total	170575	100	189161	100	201939	100

(Source: Munasinghe et al, 2011)

Impact of soil erosion has substantial socio-economic cost. For example, on-site cost due to nutrient loss alone is estimated to be Rs 953 million from the Upper Mahaweli Watershed (Gunatilake and Gunawardena, 1999). Less water retention capacity aggravates the impact of drought on crop yields. Prolonged drought in 1992 reduced the tea yields by about 26% compared to 1991, thus costing the country an economic loss of Rs 3 billion. This shows that economic cost of soil erosion is very significant and its effect on farming community and the country at large is substantial.

There were more than seven major projects undertaken in the upper Mahaweli Watershed area to combat soil erosion since 1975, funded by various foreign donors (Gunawardena, 2008). These projects have undoubtedly contributed to reduce land degradation due to soil erosion, though the problem still exists due to various reasons as explained in a following section under barriers to adoption of soil conservation.

Climate Change

i) Rainfall Variability and Associated Impacts

There have been number of studies conducted in Sri Lanka with regard to rainfall with various conflicting outcomes**.** A trend indicating decreased rainfall has been observed over the past 30-40 years, but the change is not statistically significant. Precipitation patterns have changed but conclusive trends are difficult to establish. Analysis by the Sri Lankan Department of Meteorology indicates an increasing trend in rainfall variability over most parts of the island. This finding is also confirmed by many researchers. There is also an increasing trend of one-day heavy rainfall events across the country (MoE, 2010).

The unpredictability and the extreme nature of rainfall event can be seen in recent rainfall events in Sri Lanka. Since December 2010, the country has experienced its highest level of rainfall in almost 100 years. The worst case of flooding occurred around mid-January 2011 in the Eastern Province with Batticaloa experiencing its third highest ever level of rainfall in a single day. Overall, the flooding in the Eastern Province was the worst since 1913.

The occurrence of landslides has also increased over the years. Until the year 2002, the annual average number of landslide records did not exceed 50. However, according to the disaster data, a sudden increase in the occurrence of landslides has occurred during the years 2003-2008. The records of landslides are high in the months of May and June and once again from November to January, showing a clear relationship with two monsoon seasons in Sri Lanka. The second peak is higher than the first and November has the highest recorded landslides, exceeding more than 275 incidents (http://www.desinventar.lk). With respect to spatial distribution, most landslides appear to occur in the central part of country as shown in Annex 4.

On average Sri Lanka faces drought conditions every 3-4 years. However in the recent few decades more droughts were experienced. It is also important to note that major droughts occurred in 1992 and 2001. The seasonal distribution shows that droughts occur largely in the month of August. People were most affected by severe droughts that occurred in the years of 2001 and 2004 (http://www.desinventar.lk).

ii) Temperature

The temperature in Sri Lanka has increased by 0.64°C over the past 40 years and 0.97°C over the last 72 years, which reveals a trend of 0.14°C per decade. However an assessment of a more recent time band has shown a 0.45°C increase over 22 years, suggesting a rate of 0.2°C per decade (MoE, 2010). Seasonal mean temperatures for the *Yala* (April–September) and the *Maha* (October–March) agricultural seasons also display similar warming. Mean daytime maximum and mean nighttime minimum air temperatures have both increased during the period 1960-2001 with trends of 0.026 °C and 0.017 °C per year, respectively.

Climate Change impacts on Agricultural Production and Food Security

The high variability of rainfall due to climate change will adversely affect agro-ecological regions, and hence affect the crops and livestock that they support. For example, high intensity rainfall will affect harvesting and soil erosion in tea lands and reduce the days suitable for rubber tapping (MoE, 2010).

High intensity rainfall events could, i) increase the intensity and frequency of water related disasters such as floods and landslides, which will in turn adversely affect all types of agriculture and livestock production in areas that are naturally prone to these disasters; especially in flood prone areas and steep slopes prone to landslides, ii) cause severe soil erosion and loss of plant nutrients due to heavy surface run-off in agricultural lands located

on steep slopes. Soil erosion would also compound flood damage to crops and farming communities, and cause siltation of irrigation reservoirs.

Variability of rainfall pattern is the greatest in the northeast monsoon (Chandrapala, 1996) which is the main season for crop cultivation. It is reported that changes in precipitation have a stronger effect on agricultural productivity than temperature (MoE, 2013). The variability of the north-east monsoon that brings rains for the major cultivation season will, therefore, affect production of paddy and other field crops.

The Dry Zone shows an increasing number of consecutive dry days due to rainfall variability. As nearly 70% of the paddy cultivated in Sri Lanka is in the Dry Zone, where the annual rainfall is markedly variable temporally, and less than 1,750 mm on average, this trend can adversely affect paddy yields. Droughts that are already a feature of the Dry Zone could become more prolonged, leading to reduction or loss of agricultural productivity in paddy lands that are rain-fed and/or irrigated. As much of the island's irrigated paddy lands are in the rain limited Dry Zone, more prolonged droughts may cause serious socio-economic impacts and imperil the future food security of the country (MoE, 2010).

The International Water Management Institute (Eriyagama et al, 2010) completed a study which attempts to identify the country's agricultural vulnerability hotspots through the development of a Vulnerability Index consisting of three indices, namely, exposure, sensitivity and adaptive capacity. The vulnerability maps thus developed indicate that typical farming districts such as Nuwara-Eliya, Ratnapura, Anuradhapura, Badulla, Matale and Polonnaruwa are more sensitive to climate change than the rest of the country due to existing soil erosion (up to 60 percent of the land area in Nuwara-Eliya district is affected) and their heavy reliance on primary agriculture.

The increased temperature can have serious consequences on crop production. Heat stress could occur in crops, which will be aggravated by the lack of water due to reduced rainfall. Increased evapo-transpiration together with dryness caused by droughts, may reduce surface water available for irrigated agriculture, reduce stream flow and groundwater recharge, and reduce availability of water for crop production, especially in the Dry Zone. Increased evaporation of soil water, coupled with less rain, could increase salt accumulation in the soil of the Dry Zone. This can lead to salinization of soil and loss of production in agricultural lands—particularly in the Dry Zone coastal areas.

Annual cropping systems of most parts of Sri Lanka consist of rice in the lowlands and short-term annual crops such as upland cereals (e.g. maize and other coarse grain cereals), grain legumes (e.g. green gram, soya bean, ground nut, black gram etc.), and a range of vegetables and condiments (e.g. chilli and onion) in the uplands. Impacts of climate change on rice has been investigated extensively both in Sri Lanka (Weerakoon *et al.*, 2010; De Costa, 2010) and overseas. However, very little in-depth research has been done on the climate change impacts on upland annual crops. Therefore, a study has been commenced at the Postgraduate Institute of Agriculture of the University of Peradeniya (PGIA), Sri Lanka to address this significant knowledge gap and focus on upland annual crops as represented by an upland cereal (Maize), a grain legume (Green gram), a vegetable (Tomato), a tuber crop (Potato) and a spice crop (Chilli). Another long term research study has also been initiated at the PGIA to find the impact of climate change on food security with the Canadian IDRC funding.

The vulnerability of paddy and plantation sectors has been studied and the expected impact has also been estimated by the Ministry of Environment (2010). As an example, the vulnerability of the paddy sector is given in Annex 5. The estimated impact due to drought

exposure as a result of climate change is expected to increase droughts throughout the country and is concentrated in the Dry and Intermediate Zones. A total of 16 District Secretariat Divisions (DSDs) emerge as highly vulnerable to drought exposure. These DSDs have 59,117 livelihoods dependents 347,186 ha of agricultural lands of which 176,852 ha (50.9%) are cultivated with paddy. Anamaduwa (Puttalam District), Ambalantota (Hambantota District), and Polpithigama (Kurunegala District) emerge as the DSDs most vulnerable. In these DSDs, farmers, on average, earn 62% of their income from agriculture. This shows that the impact of climate change has a very strong impact on the livelihood of rural communities.

It is not only remote villagers who experiences climate shocks. The government has lost large amounts to climate change over past decades, especially during last five years. The newly constructed infrastructure in the north and east had been damaged by heavy floods in 2010, 2011 and 2012. The drought in 2012 reduced paddy production in the Yala season by 41%. Again due to drought, hydro reservoirs dried up and generation from hydro power dropped to a dismal 18% in 2012 (Sunday times, 2013).

Barriers to adoption of soil conservation

Soil erosion could be mitigated by adopting proper land use and the adoption of soil conservation measures in agricultural lands. Whilst some land use/conversions decisions are taken directly by the government, some land use/conversions and soil conservation decisions are taken by individuals. Hence the major focus of approaches to mitigate soil erosion has been in regulating/internalizing decisions and activity of individuals. These approaches include enacting legislation on land use decisions and provision of economic incentives in the form of subsidies to adopt soil conservation measures.

Legislation by and large had very marginal effectiveness, due to primarily weak enforcement. Subsidies and project based investments, although have shown effectiveness during project implementation period, have not been sustained. The constraints to adapt soil conservation measures in terms of technical, economical, policy and intuitional limitations are described in the following section.

Technological Constraints

The Natural Resource Management Centre (NRMC) of the Department of Agriculture (DoA) is the leading organization which obtains its mandate for soil conservation from the Soil Conservation (amendment) Act No. 24 of 1996. This agency deals with formulation and reform of agricultural policy/laws and regulations for the DoA with respect to soil and water conservation. It is also responsible for promoting and implementing the Soil Conservation Act and for supporting and implementing laws and policies with respect to the agricultural sector.

The soil conservation measures to be adopted in the agricultural sector are recommended by the NRMC. However, such measures vary according to the climate, crop, landform, investment available etc. and need to be selected by seriously looking at the acceptance, adaptability, effectiveness and sustainability, especially with regard to maintenance of such measures. Gunawardena and Esser (2000) have reviewed the experiences in Sri Lanka and recommended soil conservation measures to be implemented under the Asian Development Bank funded Upper Watershed Management Project (ADB, 2006) which supported farmers to implement soil conservation activities in Uma Oya Watershed. Sloping Agricultural Land Technology (SALT) has been promoted in the upper watershed areas of the country by many local as well as foreign funded projects over many decade. However, the adoptability has been very poor since famers are not willing to allocate lands for SALT hedges due to small land sizes and the competition for water and nutrients. Mechanical measures are more

acceptable and effective and found to be popular as a soil conservation measure among farmers in the upper watershed areas where intensive vegetable cultivation is the predominant land use. The success of this approach adopted by the ADB (2006) has shown by the fact that 12,196 ha of soil conservation along with conservation farming has been adopted by farmers compared to what was originally planned (i.e 4000 ha). This approach of selecting appropriate technical options appears to work well if encouraged by technical and financial support.

Economic constraints

Soil erosion has on-site economic impacts of reduced crop productivity due to reduced fertility, degraded soil structure and reduced water holding capacity etc leading to private costs. Further, soil erosion has off-site economic impacts such as changes in the quantity, quality and time of water availability for downstream use such as domestic use, irrigation and hydropower generation as a result of reservoirs siltation leading to social costs.

Farmers are concerned only with on-site costs of soil erosion although society is concerned with off-site costs (externality) as well. The level of investments a farmer would undertake would be based only on averting private cost of soil erosion. Based on extensive analysis, Clark(1994) has concluded that the cost of technologies available for soil conservation are higher than the private benefits that could be derived from adoption of such technology thus resulting to non-adoption of most soil conservation technologies.

This reason is being used to justify the introduction of subsidy for soil conservation, mainly to sustain the resource base (soil) on which the food security of the country depends.

Policy constraints

It is typical that in a developing country, thousands of small farmers operate under ill defined and poorly enforced property rights on land. If rights are not secure, the expected benefits of investing soil conservation are reduced. This condition encourages individual farmers to over exploit the lands leading to soil erosion. In Sri Lanka most of the lands in the hill country, i.e. about 80%, is under government ownership. The state land encroachment survey of 1979 reported that 10% of the government land was encroached (Minifi, 1997). Insecure land ownership discourages farmers undertaking long-term investments on soil conservation since returns are not assured, whilst encroachment continues. However, the government, over the years, has alienated lands to landless people thus addressing this problem to a greater extent. For example, the Upper Watershed Project identified 11,000 encroached plots in the project area and out of which 7,588 were regularized with the titles allocated (ADB, 2006).

Policies to promote productivity or to achieve social equity etc may have indirect adverse impact on soil erosion. It has been clearly demonstrated that import restrictions on potato through tariff to have a causal linkage with increased soil erosion in the hill country (Somarathne, 1997). However, the government is reluctant to remove import tariff due to social and political reasons.

Institutional constraints

The Department of Agriculture, which was mandated to control soil erosion in the country with the introduction of Soil Conservation Act of 1951, was able to control soil erosion to a greater extent through its soil conservation division, which had more than 65 staff in 1960s. The necessary powers have been granted to the Director General of Agriculture through the same Act. The Natural Resources Management Centre, which now looks after the implementation of updated soil conservation Act of 1996, with the absence

of soil conservation division, which was closed down in early 1980s, does not have adequately trained technical as well as extension staff in addition to limited physical and financial resources.

As indicated before, the upper watersheds of the major rivers in Sri Lanka is located in environmentally vulnerable areas with high soil erosion potential and is important for hydropower generation, plantation agriculture, intensive vegetable cultivation etc. Recognizing the importance of securing the environmental equilibrium by preventing further land degradation in the watershed areas of the central highlands, the government of Sri Lanka intensified campaigns of soil conservation and watershed management programmes. For that purpose, a separate institute called Hadabima Authority of Sri Lanka (HBA) was established as a State Corporation under the Act no 11 of 1972 under the Ministry of Agriculture. This authority was established in 1978 under the name NADSA and changed its name in 1992 as HADABIMA targeting sustainable agricultural development through soil conservation, watershed management, crop diversification etc. But its activities are restricted to few districts.

There have been other institutions, such as Forest Department, Environment and Forest Conservation Division of the Mahaweli Authority of Sri Lanka and local authorities which have been active in controlling soil erosion through watershed management programmes when there were adequate foreign funding from 1970s to 2000. However, there is hardly any such programme as at present. Therefore, soil conservation activities are carried out by the NRMC and HBA with inadequate staff and very little funding allocated by the government of Sri Lanka. They usually get the support of the staff in the Provincial Department of Agriculture and Agrarian Development Department to implement activities on the ground.

Over the past three decades watershed management projects in Sri Lanka have evolved to become much more people-friendly (Gunawardena, 2005). However, one of the main failures of such projects was the inability to set up a sound institutional mechanism to sustain project activities after their completion. The lack of institutional collaboration in the past has been a major weakness in managing watersheds. The proposed integration of rural-level organisations as identified in the watershed Management Policy of Sri Lanka is a very challenging task for the future watershed management activities.

A recently completed evaluation study of soil conservation activities of the HBA by HARTI (2013) has recommended to strengthen project monitoring by an institutional arrangement which will include the active participation of field level government officers of the Central and Provincial Departments of Agriculture, Officers of the Agrarian Development Department, other related Institutes of Agriculture, *Samurdi Niladari* and *Grama Niladari* officers (the latter two categories of officers are recruited at the village level).

Best/Appropriate management practices

The soil and water conservation program have been implemented in Sri Lanka as a component in more holistic watershed management programmes in the past. In addition, the mode of implementation has also changed over the years and the attributes of such an approach is given in Table 5 (Gunawardena, 2005). This approach has been successfully adopted in the last watershed management project, i.e. Upper Watershed Management Project, implemented in the country during 1998-2005, where more than 100,000 farmers has benefited from overall project approach through soil and water conservation interventions which led to improved soil fertility, reduced inorganic fertilizer application, increased irrigation interval and improved income(ADB, 2006).

Table 5 Past and present approaches of watershed management projects in Sri Lanka

Previous approach	Present approach
Uni-sectoral with no need for coordination	Multi-sectoral with high level of coordination
State owned	State and user owned
Implemented by paid state employees	Implemented by users, NGOs, and the state
Capacity building of state employees	Capacity building of beneficiaries and state employees
Beneficiaries are not clear	Beneficiaries are known
No involvement of users	Involvement of users at planning, implementation and monitoring stages
Gender concerns not included	Gender concerns included
Cost-recovery is not a concern	Emphasis on income generation and cost recovery
Hierarchical governance	Distributed and market-led governance

(Source: Gunawardena, 2005)

One of the addition as at present to more holistic soil and water conservation programmes in the past is the inclusion of interventions to address anticipated impact of climate change in order to prepare the local communities for adaptation. Secondly, the location of projects and programmes has spread from upcountry wetzone to include the dryzone, where impact of climate change has a profound impact of agricultural production and food security. The lesson learnt from a recently concluded UNDP funded projects in Sri Lanka, adopted from the article titled "Can people tackle climate change, when science remains uncertain?" in Sunday Times, 4th August 2013, has given the direction to be followed in future programmes which takes soil and water conservation and climate change adaptation strategies into account.

With development aid from Australia and technical support from a number of government agencies, UNDP GEF SGP (Global Environmental Facility, Small Grants Programme) in Sri Lanka has implemented five village based project in identified 'at risk' locations throughout the country during the period 2010-2012. In sharing the experiences of practical adaptations to climate variability, a meeting was held in July 2013 to spark the government into incorporating some of the learning and experiences into national development and state-funded poverty alleviation programmes. Projects were implemented in locations prone to frequent drought, flood, erosion/landslides and coastal disasters. In all selected villages, the frequency and intensity of these disasters have increased during the last decade compared to the long-term average.

The suggestion from the project learning includes the following;

1. There is a great need for technological development to reach the rural farmers and fisherman. Those include new varieties of climate and pest resistant crops; new techniques in water and land management; new breeds of livestock and early warning systems that could save lives, tools and implements of people.

2. There is need for safety nets in rural areas in terms of access to low-interest credit, compensations schemes and insurance to ensure that farmers and fisherman can return to their livelihood after disaster.

3. Highly vulnerable districts have now been identified and this present an opportunity for Sri Lanka to design localized plans and strategies to overcome climate change,

because obviously the problems of different geographical areas are different and cannot be tackled by national level policy alone.

4. Take a landscape approach to development. Many rural development projects are narrowly planned and cause disruptive consequences on the natural and social environment. For example, if rehabilitating a village tank, ensure that catchments areas is conserved and future siltation is reduced.

5. At local level, interventions succeed if the two arms of local (Divisional Secretariat and *Pradeshiya Sabhas*) bodies cooperate for results. This is especially so in urban and semi-urban areas where the influence and responsibility is on the *Pradeshiya Sabha* to satisfy basic requirement of people.

National Action Programmes on Soil and Water Conservation

The country's development policy framework "*Mahinda Chintana* – Vision for the Future" has clearly indicated the guidelines in preparation of all policies to achieve its goals for sustainable development. In line with this national policy framework, several important projects and programmes, such as "*Haritha Lanka*" programme have been implemented by the Ministry of Environment and the agencies under its purview to address the key challenges in the field of environment and natural resources (MoE, 2010).

This *Haritha Lanka* programme was developed through an interactive process involving all key ministries. Its mission is to focus on addressing critical environmental issues which, if left unattended, would frustrate the nation's economic development programme. Actions to address key issues that would enable sustainable development are embodied in the strategies and proposed actions and set out under the ten missions of the *Haritha Lanka* Programme. The implementation of the programme is overseen by the Ministry of Plan Implementation.

The 10 missions of the Action Plan for *Haritha Lanka* Programme include;

1. Clean air – everywhere
2. Saving the fauna, flora and ecosystems
3. Meeting the challenges of climate change
4. Wise use of the coastal best and the sea around
5. Responsible use of the land resources
6. Doing away with dumps
7. Water for all and always
8. Green cities for health and prosperity
9. Greening the industries
10. Knowledge for right choices

The action plans under 3rd and 5th missions are directly related to the issues discussed in this paper.

"*Haritha Lanka*" Programme was launched by the Ministry of Environment in the year 2009. Recognizing the gaps of implementation process of this programme, the Ministry has taken initiatives to revisit it in order to ensure the sustainable development of the country. The "*Deyata Sevana*" National Tree Planting Programme by planting 11,00,000 trees island wide was launched in the year 2010. This national programme highlights the commitment towards a "Green Country" theme outlined in the *Mahinda Chinthana* – Vision for the Future policy of Government.

The Ministry of Environment has prepared National Climate Change Policy aiming at adaptation to and mitigation of climate change impacts within the framework of sustainable development. Collaborative action at all levels is an imperative to transform this policy into meaningful action and achieve the expected outcomes (MoE, 2010). Sector vulnerability profiles in Agriculture and Fisheries, Water, Heakth etc and climate change strategies for years 2011-2016 have been prepared by the Climate Change Secretariat of the Ministry of Environment, Sri Lanka and are available in the public domain (www.climatechange.lk).

There is also a National Policy and Strategy on Cleaner Production for Agriculture Sector, prepared in 2012 by the Ministry of Agriculture in collaboration with the Ministry of Environment, to ensure food security of the people while maintaining the ecological balance for the benefit of the mankind.

Though there are many strategies proposed, action on the ground to address soil and water conservation along with climate change adaptation have been limited to routine activities undertaken by the NRMC, HBA and projects, such as Global Environmental Facility, Small Grants Programme of the UNDP funded by Foreign donors as described in the previous section. A more comprehensive project to address soil erosion and climate change issues is about to commence with the funding from the World Food Programme (MoE, 2013).

The World Food Programme will implement the proposed project with the Ministry of Environment in coordination with the Ministry of Agriculture and Ministry of Agrarian Services and Wildlife. The project targets rain-dependent farming families in two hazard-prone divisional secretary divisions (DSDs) in the Mahaweli Basin identified through a vulnerability analysis. The 1st one is highly prone to landslides in the upper elevations with very high erosivity with seasonal dry periods. The 2nd one is highly prone to drought and has high exposure to climate change induced drinking water drought and irrigation drought. The project will target 14,039 farming families in minor and village irrigation systems.

The overall objective of the project is to secure community livelihoods and food security against climate change-induced rainfall variability leading to longer droughts and more intense rainfall. To directly address these climate-induced impacts, the project proposes to, a) develop household food security and build resilient livelihoods for rain-fed farming households, and, b) build institutional capacity in village, local, regional service delivery to reduce risks associated with climate-induced rainfall variability. The project is expected to deliver tangible impacts on the ground that include increased local availability of food, livelihoods that can withstand current climate shocks, more information on risks and adaptive strategies, better connectivity to early warning and risk forecasting and, importantly, an efficient and informed agriculture extension service.

The outcomes and outputs are designed to address specific vulnerabilities faced by rain-dependent farmers; strategies to overcome dry season food and income security; introduction of diversified income sources to broad-base risk, improved water storage and irrigation to overcome uncertainty of rainfall, improved soil quality and fertility for increased production, and timely, quality agriculture advice and extension.

The project is expected to serve as a learning model that will allow national technical agencies to test out their own assumptions for community-based adaptation. This is especially true of the strategy of the Government of Sri Lanka to protect food security and agricultural livelihoods from climate related impacts. This will provide the government with the opportunity to review context specific approaches establish best practices and scale up successful activities to achieve resilience communities and ecosystems to climate impacts in a wider landscape.

Conclusion

Land degradation in Sri Lanka due to soil erosion and declining soil fertility is continuing irrespective of interventions made during last few decades. The consequences of this problem on food security and resulting poverty are further enhanced by the presence of climate change.

It has been shown that the soil and water conservation programs in Sri Lanka need to have a more holistic approach to make them effective (Gunawardena, 2005, ADB, 2006). Therefore, this approach need to be further improved by incorporating additional interventions to address impacts of climate change so that the local communities would be able to adapt in order to reduce the impacts on agriculture and livelihood.

Sri Lanka has already taken steps to face the climate change impacts by undertaking vulnerability studies due to climate change on agriculture and food security, biodiversity, water and health. In addition, policies and strategies in the above sectors have been prepared up to 2020. What needs to be done at present is to translate them into action on the ground.

The recently concluded action programmes on climate change adaptation to improve agricultural production and food security of local communities has shown the parameters that need to be incorporated for action programmes. A more comprehensive project to address soil erosion and climate change issues is about to commence and the project is expected to serve as a learning model that will allow national technical agencies to test out their own assumptions for community-based adaptation with the intention of assuring food security and protecting agricultural livelihoods.

References

ADB (Asian Development Bank). (2006). Sri Lanka: Upper watershed Management Project, Project Completion Report, Asian Development Bank, http://www.adb.org/sites/default/files/projdocs/2006/28162-SRI-PCR.pdf

Chandrapala, L (1996). Calculation of areal precipitation of Sri Lanka on district basis using Voronoi Tessalation (Theisen Polygen) method. Proceeding of the National Symposium of the Climate Change, Colombo, 7-8 March 1996.

Clark, R. 1994. Economic valuation of soil erosion and soil conservation measures: A case study of the Perawella area in the Upper Mahaweli Catchment. Forest/Land Use Mapping Project. Technical Paper No. 10. Ministry of Mahaweli Development, Colombo.

De Costa, W.A.J.M. (2010). Adaptation of agricultural crop production to climate change: a policy framework for Sri Lanka. *Journal of the National Science Foundation of Sri Lanka* 38: 79-89.

DNP (Department of National Planning). (2010). Sri Lanka: The Emerging Wonder of Asia, *Mahinda Chinthana-Vision for the Future,* The development policy framework of Government of Sri Lanka. Department of National Planning, Ministry of Finance and Planning, Colombo, Sri Lanka. 304p

DSC (Department of Census and Statistics). (2003). Statistical Abstracts 2002. Department of Census and Statistics, Colombo, Sri Lanka.

Eriyagama, N Smakhtin, V Chandrapala, L Fernando, K. (2010) Impacts of Climate Change on Water Resources and Agriculture in Sri Lanka. IWMI Research Report 135

Gunatilake, H.M. and E.R.N.Gunawardena. (1999). An assessment of on-site and off-site cost of soil erosion in the Upper Mahaweli Watershed. Sri Lankan Journal of Agricultural Sciences, Vol.37, 103-134.

Gunawardena, E.R.N. (1995). "Rapid assessment of the importance of natural forests for watershed protection". In: Proceedings of the fifth annual American Geophysical Union - Hydrology Days. (Ed. H.J.Morel-Seytoux), Colorado State University, Fort Collins, Colorado. USA. pp: 71-82.

Gunawardena, E.R.N and Esser, K. (2000). Soil conservation and hydrological monitoring. Consultancy Report. Upper Watershed Management Project. Ministry of Forestry and Environment, Colombo, Sri Lanka.

Gunawardena, E.R.N. (2005). Evolution of watershed management. In: Preparing for the next generation of watershed management programmes and Project, ASIA (Eds: M Achouri, L Tennyson, K Upadhayay and R White). Watershed management and sustainable mountain development working paper, Food and Agricultural Organization, Rome. 149-155.

Gunawardena, E.R.N. 2008. Watershed Management: The path traversed and the way forward. In: Development in Forestry and Environment in Sri Lanka (Ed:H.S.Amarasekera et al). Proceeding of the Silver Jubilee Conference, 29 December 2008, University of Sri Jayawardenapura, Sri Lanka. 62-71.

Herath, H.M.K.V., Gunawardena, E.R.N. and Wickramasinghe, W.M.A.D.B. (2013). The impact of "*Kethata Aruna*" fertilizer subsidy scheme on fertilizer usage and paddy production in Sri Lanka. Paper submitted for Annual Congress of the Postgraduate Institute of Agriculture, University of Peradeniya, Sri Lanka.

Kenderagama, K.M.A.(2013) Sustainable approach towards combating land degradation in the central highlands of Sri Lanka in the face of climate change. In: SOBA: A special Magazine Published for Rio+20 summit. Ministry of Environment, Colombo, Sri Lanka. 27-31.

Kotagama, Hemasiri, Sunil Thrikawala and Nimal Gunawardena. 1998. Impact of macro-economic policies on soil erosion: A simulation study.EA1P Project, Environmental Division, Ministry of Forestry and Environment, Colombo.

Krishnarajah, P. (1982). Soil erosion and conservation in the upper Mahaweli watershed. Paper presented at the Annual Session of the Soil Science Society of Sri Lanka on 13th November 1982. 15p

Minifi, J. 1997. Institutions and Land degradation in Sri Lankan Hill country. Paper presented at the workshop on land degradation and policy option in Sri Lanka.

MoE (Ministry of Environment). 2011. Progress Report and Action Plan 2012. Ministry of Environment, Sri Lanka. http://www.environmentmin.gov.lk.

MoE (Ministry of Environment). (2010). Climate Change Vulnerability in Sri Lanka: Sector vulnerability profile (Agriculture and Fisheries). Supplementary Document to: The National Climate Change Adaptation Strategy for Sri Lanka 2011-2016. Climate Change Secretariat, Ministry of Environment, Sri Lanka. www.climatechange.lk

MoE (Ministry of Environment). (2013). Draft proposal for climate change adaptation. Ministry of Environment, Sri Lanka.

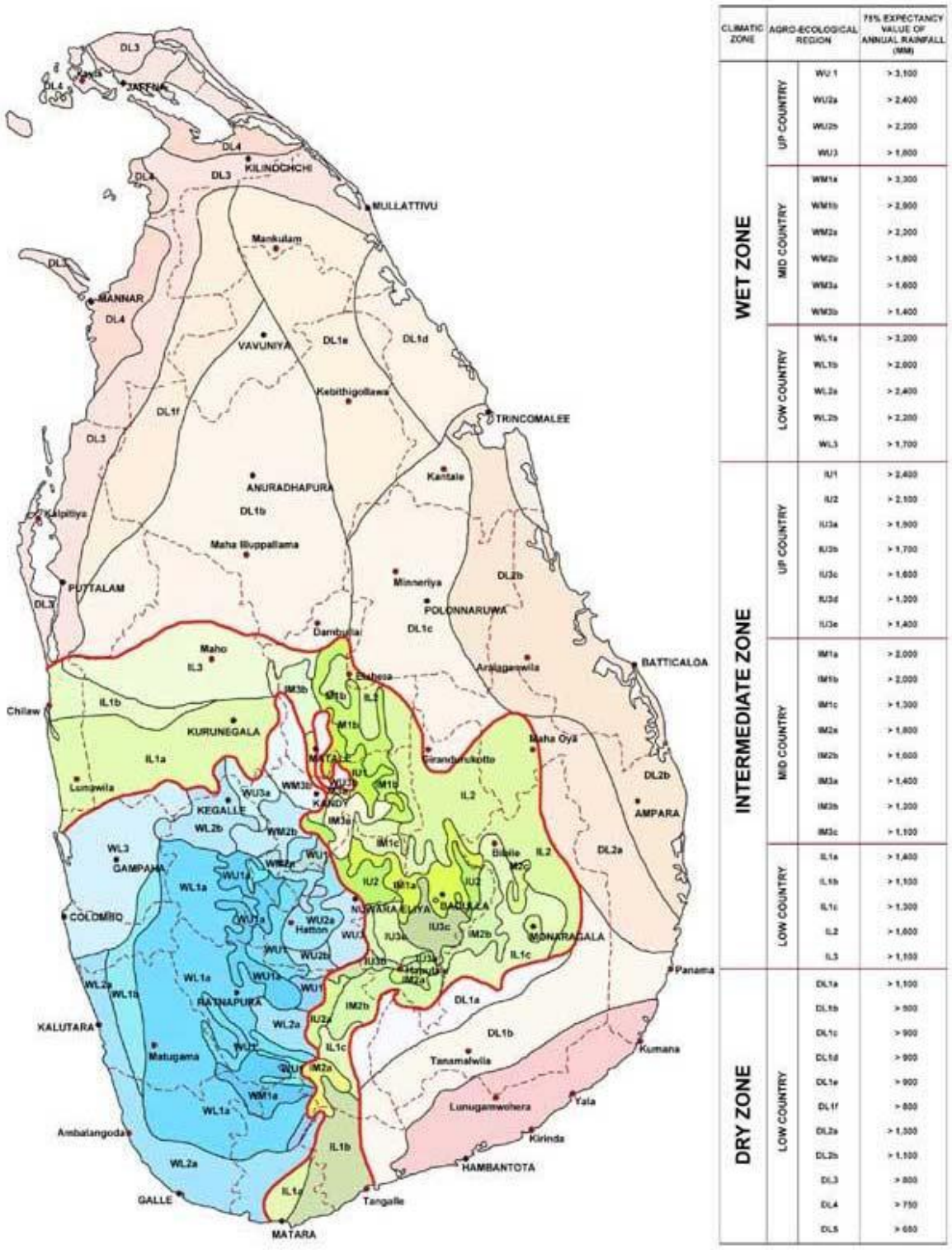
Munasinghe, M.A.K., Pushpakumara, S.M.P., and Bandara, T.M.J. 2001. Use of geographical information systems for soil erosion hazard assessment of Central Province of Sri Lanka. Annals of Department of Agriculture, Kandy, Sri Lanka.

Nayakakorala, H.B. 1996. Soil degradation and other environmental problems related to agriculture in Sri Lanka. National Workshop on International Strengthening and Collection of Environmental Statistics, Natural Resources Management Centre, Kandy, Sri Lanka.

Somaratne, W.G. 1997. Policy liberalization and the environment in Sri Lanka: A computable general equilibrium analysis. Paper presented at the workshop on land degradation and policy options in Sri Lanka held in 1997.

Weerakoon, W.M.W., De Costa, W.A.J.M. & Nissanka, S.P. (2011). Review of the Impacts of climate change on rice in Sri Lanka. *Proceedings of the 4th Rice Congress*, 2-3 December,

2010, Gannoruwa, Sri Lanka. Rice Research and Development Institute, Department of Agriculture, Sri Lanka.



Annex 1. Agro-ecological regions in Sri Lanka

Annex 2a. Statistics on production of paddy

Key Indicator	2005	2009	Anticipated targets	
			2015	2020
Land Use –Sown extent of maha season ('000 ha)	581	631	700	730
Sown extent of yala season ('000 ha)	357	345	480	540
Extent of abandoned paddy lands ('000 ha)	150	100	30	No
Productivity of paddy lands (mt/ha)	2.06	4.3	5.5	6.5
Annual production of paddy (mil. mt)	2.24	3.64	6.5	8.2
Provision of quality seed paddy	24%	35%	60%	100%

(Source: DNP, 2010)

Annex 2b. Present production, imports and production targets of OFC

Other Field Crops	Production (mt)		Imports (mt)		Production Targets (mt)		Import Targets (mt)
	2005	2009	2005	2009	2015	2020	2015
Big Onion	55,550	81,707	110,713	143,237	240,570	250,300	1,000
Red Onion	53,730	46,232	10,233	16,208	56,500	60,750	500
Dried Chilies	11,749	10,318	27,260	36,015	52,500	60,850	2,000
Maize	41,800	129,769	146,930	27,200	270,320	350,000	2,000
Kurakkan	6,450	6,433	1,380	3,272	27,150	46,600	100
Green gram	9,000	9,258	9,320	14,183	45,170	66,900	200
Black gram	6,920	7,071	4,641	3,349	18,590	26,760	150
Cowpea	11,180	13,480	195	429	20,000	35,000	50
Soy bean	4,990	6,050	1,310	1,790	14,600	19,250	50
Ground nut	9,040	13,077	4,880	3,950	21,920	26,760	0
Gingerly	6,160	8,523	27	23	17,650	26,760	0

(Source: DNP, 2010)

Annex 2c. Present production, imports and production targets of potato, vegetables and fruits

Crops	2009		Target 2015		Target 2020	
	Production (mt)	Export/(Imports) (mt)	Production (mt)	Export/(Imports) (mt)	Production (mt)	Export/(Imports) (mt)
Potato	61,700	(95,000)	105,500	(60,000)	150,000	(25,000)
vegetables	840,450	(260)	1,200,000	200,000/(30)	1,500,000	350,000/(5)
Fruits						
Banana	378,336	20	440,000	20,000	491,000	40,000
Pineapple	59,550	1290	95,000	27,000	120,000	45,000
Papaw	21,138	321	33,000	8,000	45,000	15,000
Mango	70,418	63	110,000	18,000	150,000	40,000

(Source: DNP, 2010)

Annex 3a. Major Forest Plantation Areas (ha)

Plantations Year	Teak	Mahogany	Eucalyptus & Acasia (dry zone	Pines/ Bamboo	Teak/ Khaya	Other Species	Total
2000	31,700	3,700	28,275	16,440		12,225	92,340
2001	31,700	3,700	28,275	16,440		12,885	93,000
2002	31,700	3,700	28,275	16,440		12,885	93,000
2003	31,700	3,700	28,275	16,440		12,885	93,000
2004	31,700	3,700	28,275	16,440		12,885	93,000
2005	31,972	5,255	28,506	15,923	463	12,918	95,036
2006	31,972	5,255	28,506	15,923	463	12,918	95,036
2008	31,972	5,255	28,506	15,923	463	12,918	95,036
2009	30,436	5002	19,280	15,776	463	6287	95,037
2010	30,436	5002	19,280	15,776		6,287	95,037

(Source: MoE, 2011)

Annex 3b: Depletion of Natural Forests

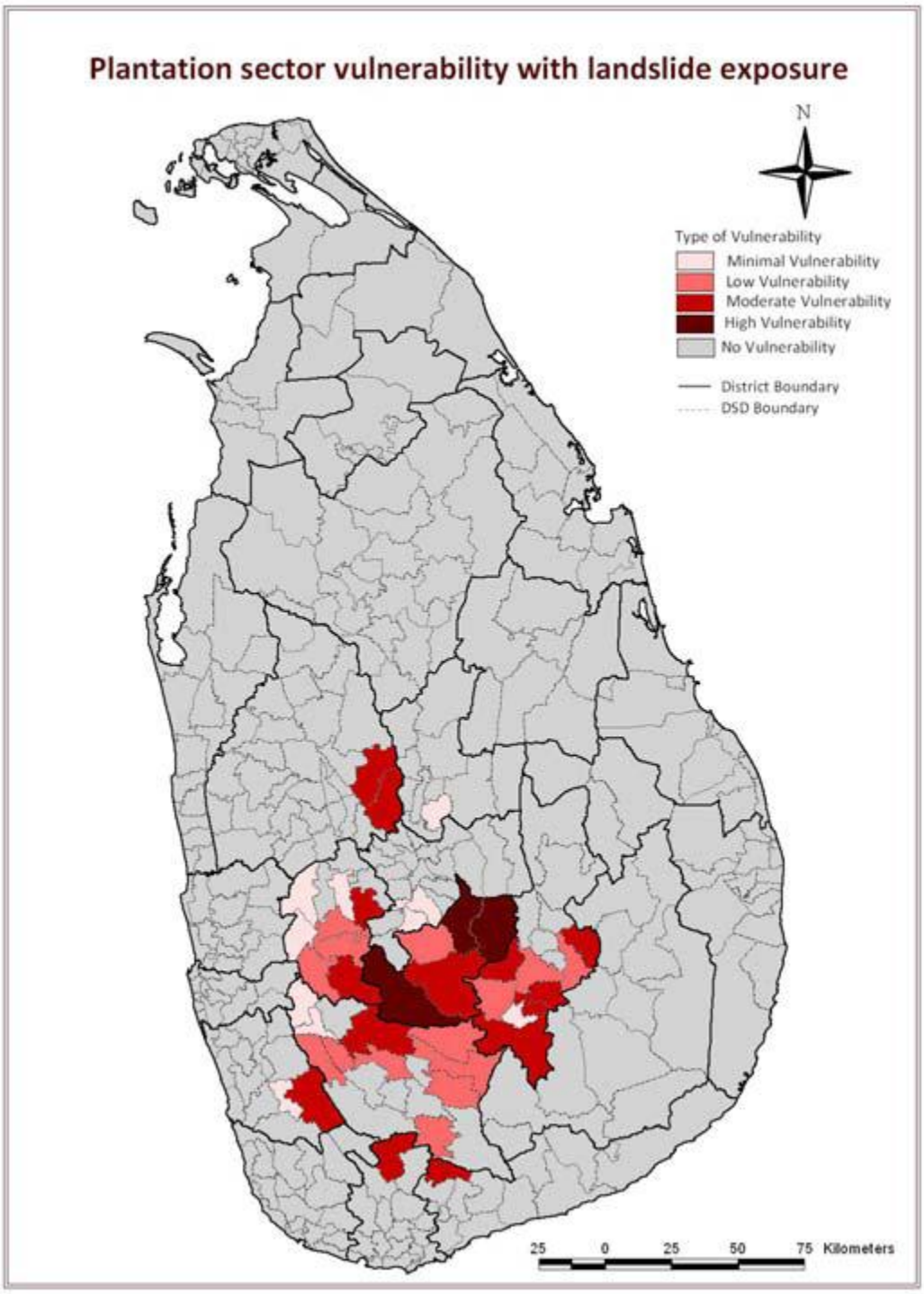
Year	Area (ha)	Percentage of total land Area	Percentage of forest Area Change	Percentage of Average Annual Depletion
1956	2,898,842	44.02		
1983	2,458,250	37.50	15.19	0.56
1992	2046,299	30.89	16.74	1.86
1999	1,942,219	31.00	5.10	0.72
2010	1,883,310	28.70	3.03	0.27

(Source: MoE, 2011)

Annex 3C. Extent of Natural Forest by Forest Types

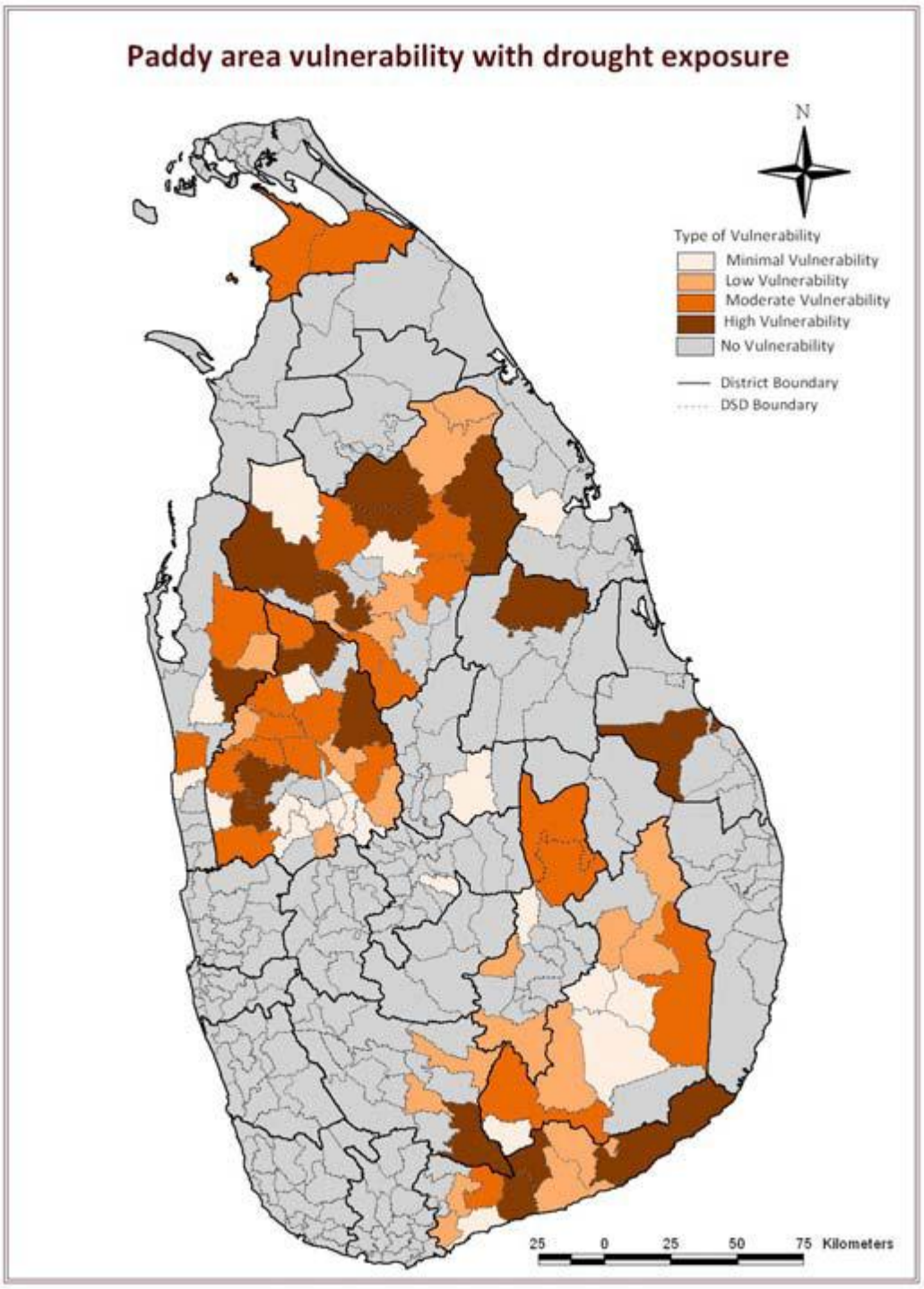
Forest type	1992		1999		2010	
	Area (ha)	Percentage	Area (ha)	Percentage	Area (ha)	Percentage
Close canopy forests						
Montane	3,108	0.05	3099	0.04	44,787	0.68
Sub Montane	68,,616	1.04	65,792	1.00	28,990	0.44
Lowland	141,506	2.14	124,341	1.89	123,889	1.89
Moist Monsoon	243,886	3.69	221,977	3.38	117,736	1.80
Dry Monsoon	1,090,981	16.49	1,027,544	15.68	1,121,589	17.11
Riverine	22,435	0.34	18,352	0.28	2,425	0.04
Mangrove	8,688	0.13	9530.50	0.10	16,037	0.24
Sub total	1,579,220	23.88	1,470,636	22.33	1,455,453	22.20
Open canopy						
Sparse	464,076	7.01	471,583	7.20	427,857	6.53
Total	2,043,296	30.89	1,942,219	31.00	1,883,310	28.74

(Source, MoE, 2011)



Annex 4. Plantation Sector Vulnerability with Landslide Exposure

(Source: MoE, 2010)



Annex 5. Vulnerability of the paddy sector to drought exposure

(Source: MoE, 2010).

Country paper: Thailand

Chinapatana Sukvibool
Division of Soil and Water Conservation Research and Development,
Land Development Department, Bangkok 10900 Thailand, Email: sukvibool@hotmail.com

I. Introduction/background

Thailand lies between latitudes5° 40' and 20° 30' N and longitudes 97° 20' and 105° 45'E in the southeastern part of the Asian mainland. Myanmar is on the western and northern borders, Laos lies to the northeast, Cambodia to the east, and Malaysia to the south of the country. The country's total land area is 513,115 sq kms (320.7 million rai). The length from south to north is about 1,650kms and 800 kms from east to west. The province with the shortest length is Prachuab Kirikhan province which covers 10.6 kms. Located in the tropical region, Thailand has a climate that is relatively warm throughout the year (Figure 1).

Topographically, Thailand falls under four classifications:

Central plains. The wide flat land in the central plains is composed of sediment and non-sediment land. The major plains are found in the upper and lower parts of the region, such as the Pasak watershed area, the eastern plain and the Mae Klong, and the Petchburi river plains.

Valleys in the north. These valleys lie between mountainous ranges. There are several plain areas in the mountainous valley of the north. The more important plains are those in Chiang Mai, Prae, and Nan.

Plateaus in the northeast. In the main, land in the northeastern region features plateaus. These are the Mae Kong River and Mun River plateaus.

Southern plain areas. Southern Thailand is located on a narrow cape that is less than 200 kms wide, the narrowest being only 60 kms wide. In the middle of the cape lies a mountain range. Hence, most plain areas in the south lie along either side of the peninsula. The important ones are the plains of Ban Don, Phattalung and Pattani.

The two principal river systems of Thailand are the Chao Phraya and the Mekong. Together, these rivers support the irrigation for Thailand's agricultural economy. In addition to these two large systems, there are a number of other river systems and individual rivers which drain the lands within Thailand's borders into the Gulf of Thailand and the Andaman Sea. The Mekong is the only river system in Thailand which drains into the South China Sea.

Over the past decade, Thailand's population growth followed a diminishing rate. It is expected that the total population will increase from 63.4 million in 2008 to more than 71 million in 2028. Thailand's demographic structure is changing with the emergence of an aging society. The elderly population will significantly increase. Approximately one-half of the total population will reside in urban areas within the next 50 years. Hence, increasing demand for basic infrastructure, public utilities and services, especially for the elderly, is envisaged.

Figure 1 Map of Thailand

Natural Resources

Land is the most important basic natural resource, especially with regards the development of forest and agriculture. Utilization of land resources is closely related to global warming. The overall allocation of land resources among agriculture, forestry, and other sectors has changed only slightly. Paddy land has more or less been constant, although the proportion of field crops to total agricultural land declined, while that of permanent trees and fruit trees increased. Thailand has long been exerting efforts to conserve forest land. Deterioration of land quality and problematic soils are major constraints to land resource development. Nearly one-third of the total land is either of low quality or with problematic soils. Many areas have been classified as drought- or flood-prone areas. Damage caused by droughts or floods has increased, with some fluctuations over time.

Experiences during the tsunami disaster have proven the ecological and environmental importance of mangroves. Public awareness of the role of mangrove forests in coastal protection has increased greatly. Nevertheless, the pressure on land and mangrove forests remains. Poaching in natural forest area continues despite the high investment made to ensure protection, which has resulted in a slight drop in the number of poaching incidents. Providing protection to land and mangrove forests is a huge task for the public sector. The need for local community participation in forest protection is a big challenge for Thailand.

Water resources are vital to all sectors of the economy. Existing water resource management has not been able to cope effectively with the demand. Water storage

capacities vary from region to region and can only partially support the demand. A large part of Thailand remains vulnerable to the limited availability of surface water. Droughts and floods have become increasingly frequent and severe. The damages are potentially aggravated by global warming. Thailand needs to develop a long-term water resource management and an administration approach that is capable of coping with higher risks due to seasonal water supply. The approach needs to ensure that the allocation and utilization of water resources are flexible enough to adapt to changing ecological systems.

Economic Development

Presently, the population is 66 million. By 2030 Thailand's population is projected to reach about 71 to 77 million. As a result of socio-economic developments and improvements in public health, the demographic structure is changing. An aging society is expected within the next few decades, accompanied by consequent decline in the labor force (Figure 1-3). Thailand faces new socio-economic challenges that require corresponding changes in the social infrastructure, in order to benefit the aging population. Technological development will have to be accelerated to enhance national productivity, as well as to respond to the society's emerging needs.

In the 1990s, Thailand suffered an economic crisis, known as the "Tom Yam Kung disease", due to the collapse of its financial sector. The crisis gradually eased and the economy recovered. Imports of raw materials and capital growth, in proportion to the national GDP, increased continuously, saving and investment gaps narrowed, the ratio of public debt to GDP declined, and the current account improved. The recovery was very short-lived, however. Thailand's economy encountered difficulties due to political instability in 2006. The economy declined, further affected by the economic crisis in the United States. Exports dropped substantially by up to minus 10%. The deep recession caused the Thai Government to implement various emergency rescue packages to restore the economy. These difficult times during the past decade caused revisions in the targets of the 8 th and 9th National Economic and Social Development Plans. Similarly, the global food and energy crises in the past two years caused revisions in the 10th Plan. In summary, national and global economic and political instabilities have had immense impacts on Thailand's economic development in the past decade. The 11th Plan, which is being prepared, places greater emphasis on economic stability and development of the country's self-reliance and resilience to external factors.

Social Development

After three decades of national development, problems associated with social issues, resource utilization and environmental concerns were on the rise. Seeking a balanced development, Thailand changed its development vision to emphasize "people" as the center of development. Starting with the 8th Plan up to the 10th Plan, Thailand has adopted the philosophy of sufficiency economy to enhance stable community development. The philosophy will also be adopted in the forthcoming 11th Plan.

A review of social developments over the past decade indicates that economic conditions at the grassroots level have improved. The proportion of poor people declined, while that of the middle income group increased. Indicators for the people's happiness increased but not at a satisfactory level. Causing most concern was the drop in the value placed on family warmth and love. The value placed on community cohesion did not improve. Considering these outcomes and the changing demographic structure, Thailand needs to improve its social development, especially the need to strengthen the family as a unit and to build community cohesion. Strong family and community relationship is a basic requirement for public participation and is a key mechanism to achieve sustainable economic and social development.

Sustainable Development of Thailand

Economic, social and natural resources and environmental concerns have been integrated into Thailand's sustainable development. Environmental quality promotion and conservation have been implemented in parallel with economic and social development since the 7th Plan. Two policy committees are working in parallel and are coordinating closely to ensure consistency and balance between economic and social development and resource conservation and environmental protection. Thailand's development vision has increasingly emphasized the social dimension to cope with the effects of globalization. To meet the quality of life objective, the philosophy of sufficiency economy and the concept of "people as the center of development" have been the fundamental principles for national development in the past 15 years. Climate change has complicated the process of sustainable development. Thailand needs to integrate the problem of global warming, especially the effects of climate change, into the policy and plan for national sustainable development. Sustainable development incorporating the international environmental phenomena is a new challenge for the Thai Government as it pursues the country's sustainable development

Objective of the paper

The main aim of this paper is to briefly describe the vision, mission and frame works/programme " the Sustainable Land Management (SLM) Thailand's Action Programme Formulation to Respond to Climate Change in Synergy with the three Rio Conventions ". Mainly, emphasized on behalf of Land Development Department's activities (LDD), Ministry of Agriculture and Cooperatives.

.

II. Situation analysis at country level

Current Situation : Natural resources and the environment in Thailand have been affected b y worldwide events including both climate change and domestic factors such as increasing population. Growth-oriented development and competition in trade and investment have contributed to the exploitation of natural resources beyond the carrying capacity of the ecosystem. At the same time, management capability and policy tools such as databases, regulations, law enforcement, and economic instruments have not been utilized efficiently. This has led to depletion of natural resources and deterioration of the environment, thereby affecting the overall balance of the ecosystem.

1. Forest areas have been damaged or destroyed, disrupting the balance of the ecosystem and endangering biodiversity. Forest areas in Thailand show a steady declining trend; they have decreased from 171 million rai in 1961 (53.3 percent of total area) to 107.6 million rai in 2009 (33.6 percent). Deforestation has damaged the ecosystem and threatened biodiversity on which community livelihood relies and that is the foundation for future economic development. Conservation management has discovered many new species in Thailand, but numbers of endangered flora and fauna have continued to increase.

2. Marine and coastal resources are deteriorating continually. At present, mangrove forests cover 1.5 million rai or 0.5 percent of the country. In addition, marine and coastal resources are under pressure from infrastructure construction, tourism, unregulated fishing, and damage from erosion. By 2007, about 115 coastal zones had eroded along approximately 600 kilometers, causing land loss of 113,042 rai, the equivalent of 100,000 million baht in damage. Moreover, shorelines along the inner Gulf of Thailand, classified as

significant national wetland areas, have experienced severe erosion in excess of five meters per year.

3. Soil has deteriorated while conflicts over land use continue. Soil resources, a major production element, have been compromised through inappropriate use and improper distribution. Land areas degraded to a severe and critical level cover 36 million rai, 11.2 percent of the country. Encroachment on conservation areas continues to occur. Moreover, the expansion of urban, industrial and commercial areas has systematically replaced agricultural lands.

4. Natural disasters such as flood and drought are more frequent and severe. The capacity for water storage for summer use is 74,000 million cubic meters but only about 55,000 million cubic meters may be used annually in irrigated areas because the required minimum storage level is 19,000 cubic meters. Water demand will increase from 57,452 million cubic meters in 2008 to 65,452 million in 2016. The Central region requires the most water, followed by the North and then the South. Therefore, the likelihood that severe water shortages will lead to conflicts over competing uses of intra- and inter-river basins will definitely increase among production sectors. Moreover, 34 percent of all villages are prone to droughts. Villages in the Northeastern river basin, in particular, are at highest risk. In addition, 2,370 villages are threatened with inundation and landslides; of these, 398 are at high risk. The Northern region is most susceptible due to degraded forests in the watershed areas.

5. Greenhouse gas emissions have risen unremittingly. In 2004, Thailand's greenhouse gases totaled 265.9 million tons, including emissions from land uses and forests. These emissions have increased 5.6 percent since 2003. Industry and energy generating sectors accounted for the highest amount, 63 percent. Agricultural, industrial and waste sectors respectively contributed 17, 7 and 4 percent of the total greenhouse gases.

a. Resource management sectors

Based on geographical characteristics, Thailand can be divided into 25 river basins. The average of annual rainfall for the country is about 1,700 mm. The total annual rainfall of all river basins is about 800,000 million m^3 of which 75 % of the amount is lost through evaporation, evatranspiration and the remaining 25 % (200,000 million m^3) is in streams, rivers, and reservoirs (see Table 1). Thus, the available water quantity was about 3,300 m^3/ capita/year (Office of National Water Resources Committee, 2000).

Water Resources Situation

National Basin Scale : Thailand Development Research Institute, (TDRI) estimated the national requirement for water use in three main types, i.e., domestic, industrial and agriculture up to the year 2010 at about 167 billion cubic meters (BCM) per annum. It was also reported by Office of National Environmental Board-ONEB (1990) based on the Royal Irrigation Department (RID) that the surface water produced by the main basins in Thailand is almost 200 BCM per year. Out of an estimated 200 BCM/yr of such renewable water resources, about 40 BCM are with drawn annually for agriculture, 2 BCM for domestic use, and 2 BCM for industry. It was also further estimated basing on the current trend that the coresponding figures would be 144, 15 and 8 BCM/yr respectively by the year 2010.

Table 1: Watershed Areas and Annual Runoff of the Major River Basin in Thailand

Basin No	River Basin Name	No Watershed area [sq.km.]	Annual run-off [million m³.]
1	Part of Salawin	17,920.19	8,156
2	Part of Mekong	57,422.07	15,800
3	Kok	7,895.38	5,119
4	Chi	49,476.58	8,035
5	Mun	69,700.44	21,767
6	Ping	33,891.71	6,686
7	Wang	10,790.74	1,429
8	Yom	23,615.59	1,430
9	Nan	34,330.16	9,518
10	Lower Chao Phraya	20,125.25	4,925
11	Sakae Krang	5,191.43	519
12	Pasak	16,292.24	2,708
13	Tha Chin	13,681.24	2,815
14	Mae Klong	30,863.76	12,943
15	Prachinburi	10,481.32	4,502
16	Bang Pakong	7,978.15	4,900
17	Part of Tonle Sap	4,149.97	1,193
18	East Coast Gulf	13,829.72	25,960
19	Phetchaburi	5,602.91	1,140
20	West Coast-Gulf	6,745.33	1,013
21	Peninsular-East Coast	26,352.78	35,624
22	Tapi	12,224.53	17,380
23	Thale Sap Songkhla	8,494.97	7,301
24	Pattani	3,857.82	3,024
25	Peninsular-West Coast	21,172.25	9,918
Total		512,065.81	214,128

Sources: Office of the National Water Resources Committee (2000)

Regional and Basin Scale : The predicted average water demand and supply previously described reflect the macro water picture which ignores the regional and basin variation. In fact, the Northeast is considerably dryer and the South is wetter than the rest of the country. The Northeast even suffers from excessive water and floods during tropical storm period, water shortage has been always occurred every dry season. These macro projections also ignore yearly variation of climatic condition and changes in land-use and urbanization.

In order to reflect, regional and basin variation in both the demand and supply and their trends to year 2010, average annual runoff produced by 25 main basins and predicted demand for all sectors were estimated based on water yield map provided by RID and TDRI method of water demand calculation. The results are shown in **Table 2.** The irrigated areas and medium

and large reservoirs developed by RID and the multipurpose reservoirs in each of those basins are presented in **Table 3.**

Estimated trend of water demand in the national scale shows that demand is still less than the amount of renewable water existing in all basins of this country. The basin estimation however indicates insufficient supply in the central region especially in the lower Chao Phraya basin and Tha Chin basin by the year 2020.

Table 2 : Regional and basin variation of water demand (estimated trend to year 2010) and supply of 25 main basins.

Basin Code	Basin Name	Drainage Area (sq.km)	Estimated Water Demand in Year (Million cubicmeters)x103(BCM)		Runoff and Sediment Yield			
					Annual Supply		Seasonal Supply	
			2000	2010	MCM Per sq.km	Basin Yield MCMx10^3	MCMx103 Wet	MCMx103 Dry
Northern Region								
01	Mae Nam Salawin	17,920	0.130	0.192	0.35	6.272	5.02	1.25
02	Mae Nam Hhong1	9,920	0.761	1.497	0.60	5.952		
03	Mae Nam Kok	7,895	0.836	1.645	0.61	4.843	3.54	1.30
06	Mae Nam Ping	33,898	6.026	11.854	0.19	6.414	3.14	3.27
07	Mae Nam Wang	10,791	0.652	1.283	0.11	1.919	1.46	0.46
08	Mae Nam Yom	23,616	1.609	3.165	0.15	3.542	2.73	0.81
09	Mae Nam Nan	34,330	4.692	9.230	0.35	12.016	8.17	3.84
(Region Total)		138,370	**14.706**	**28.867**	-	40.232	-	-
Northeastern Region								
02	Mae Nam Khong 2	47,502	2.638	5.189	0.35	16.626		
04	Mae Nam Chi	49,477	4.705	9.255	0.19	9.400	6.67	2.73
05	Mae Nam Mun	69,701	4.500	8.852	0.16	11.152	9.14	2.01
(Region Total)		166,680	**11.843**	**23.296**	-	37.178	-	-
Central Region								
10	Mae Nam Chao Phraya	20,125	27.717	54.523		3.967		

					0.20		2.42	1.54
11	Mae Nam Sakae Krang	5,192	0.833	1.639	0.15	0.979	0.70	0.10
12	Mae Nam Pasak	16,292	0.875	1.721	0.17	2.774	2.27	0.50
13	Mae Nam Thachin	13,682	8.522	15.262	0.13	1.726	1.22	0.51
(Region Total)		55,291	**37.947**	**73.145**	-	9.264	-	-
Eastern Region								
15	Mae Nam Prachin	10,481	1.605	2.614	0.60	6.280	5.65	0.63
16	Mae Nam Bang Prakong	7,978	4.679	9.204	0.28	2.264	2.13	0.13
17	Tonle Sap	4,150	0.035	0.057	0.30	1.243	1.18	0.06
18	East-Coast Gulf	13,829	1.006	1.979	0.82	11.340	9.07	2.27
(Region Total)		36,438	**7.325**	**13.854**	-	21.127	-	-
Western Region								
14	Mae Nam Mae Klong	30,837	1.605	2.614	0.44	13.615	10.48	3.14
19	Mae Nam Petchaburi	5,603	4.679	9.204	0.16	0.883	0.51	
20	West-Coast Gulf	6,745	0.035	0.057	0.35	2.113		
(Region Total)		43,185	**7.043**	**13.855**	-	16.611		
Southern Region								
21	Peninsula-East Coast	26,352	4.898	9.635	1.01	26.593		
22	Mae Nam Tapi	12,225	0.215	0.423	1.26	15.430		
23	Thale Sap Songkhla	8,495	1.963	3.862	0.94	8.037		
24	Mae Nam Pattani	3,858	0.593	1.062	0.63	2.433		
25	Peninsula-West Coast	21,172	0.476	0.852	0.10	23.368		
(Region Total)		72,102	**8.145**	**15.834**	-	75.861		
Country Total		**512,066**	**87.009**	**168.850**	**-**	**200.273**		

Table 3 : Basin area, medium and large reservoirs developed by RID and multipurpose reservoirs with irrigated areas in 25 main basins.

Basin Code	Basin Name	Drainage Area (sq.km)	Medium and Large Irrigation Project		Multipurpose Reservoir			Irrigated Area (1989) Rai**
			No	Capacity MCM	No	Capacity MCM	Power Generation MKW-hr	
Northern Region								
01	Mae Nam Salawin	17,920	12	13.08	-	-	-	34,060
02	Mae Nam Hhong1	9,920	23	76.36	-	-	-	191,150
03	Mae Nam Kok	7,895	6	?	-	-	-	196,000
06	Mae Nam Ping	33,898	50	357.75	1	13,462	1,414	1,453,200
07	Mae Nam Wang	10,791	8	125.74	-	-	-	161,700
08	Mae Nam Yom	23,616	20	32.62	-	-	-	383,552
09	Mae Nam Nan	34,330	60	17.38	1	9,510	960	1,112,130
(Region Total)		138,370	179	622.93	2	22,972	2,374	
Northeastern Region								
02	Mae Nam Khong 2	47,502	78	876.25	1	165	17	579,475
04	Mae Nam Chi	49,477	68	2589.36	2	2,452	205	996,188
05	Mae Nam Mun	69,701	102	1343.21	1	1,966	90	892,905
(Region Total)		166,680	248	3808.82	4	4,583	312	2,468,568
Central Region								
10	Mae Nam Chao Phraya	20,125	34	25.84	-	-	-	5,925,003
11	Mae Nam Sakae Krang	5,192	5	160.00	-	-	-	243,500
12	Mae Nam Pasak	16,292	12	45.12	-	-	-	202,550
13	Mae Nam Thachin	13,682	16	251.08	-	-	-	2,276,046
(Region Total)		55,291	67	482.04	-	-	-	8,647,099
Eastern Region								
15	Mae Nam Prachin	10,481	15	22.07	-	-	-	467,215
16	Mae Nam Bang Prakong	7,978	13	17.90	-	-	-	1,145,140
17	Tonle Sap	4,150	5	6.50	-	-	-	5,500
18	East-Coast Gulf	13,829	26	237.73	1	97	27	201,000
(Region Total)		36,438	59	284.20	1	97	27	1,818,855
Western Region								

14	Mae Nam Mae Klong	30,837	17	7.78	3	26,660	2,268	1,145,000
19	Mae Nam Petchaburi	5,603	8	4.39	1	710	81	342,330
20	West-Coast Gulf	6,745	14	516.79	-	-	-	246,855
(Region Total)		43,185	40	1238.96	4	27,370	2,349	1,734,685
Southern Region								
21	Peninsula-East Coast	26,352	27	2.00	-	-	-	1,051,500
22	Mae Nam Tapi	12,225	16	25.18	1	5,640	554	37,215
23	Thale Sap Songkhla	8,495	17	26.42	-	-	-	467,800
24	Mae Nam Pattani	3,858	3	-	1	1,404	200	154,403
25	Peninsula-West Coast	21,172	14	19.00	-	-	-	96,000
(Region Total)		72,102	77	72.60	2	7,044	754	1,806,918
Country Total		**512,066**	**670**	**6509.55**	**13**	**62,066**	**5,816**	**20,007,917**

Note : 1 hectare = 6.25 rai

Land resources and land use

Land is an important natural resource that supports the agriculture and non-agriculture sectors. Thailand has a total land area of 51.3 million hectares. Three types of land use are discussed here - agriculture, forestry, and others (including waterways and reservoirs). Land use for agriculture has been relatively stable at 21 million hectares or about 40% of the total land area (Table 4), whereas land use for forestry has increased slightly in proportion to the total land area due to reforestation and conservation.

Despite its relative stability, agricultural land use has seen changes in recent years. Rice-planted areas, although generally stable, slightly declined in recent years from about10.5 million hectares in 2000 to about 10 million hectares in 2006. The same is true for land planted to field crops, which dropped from 4.6 million hectares to 4.4 million hectares during the same period. Land planted to perennial crops and grass increased by nearly 300,000 hectares between 2004 and 2006.

The shift in land use from annual to perennial crops was due to changes in the climate and market conditions. Frequent droughts motivated farmers to grow fast-growing trees for the paper industry. Also, high prices for rubber and palm oil induced farmers, particularly in the south and northeast, to switch to these two crops. It is important to note that switching from annual to perennial crops reduces the farmers' flexibility to adjust to external factors, and hence exposes them to higher climate change risks. The shift in land use from annual to perennial crops was due to changes in the climate and market conditions. Frequent droughts motivated farmers to grow fast-growing trees for the paper industry. Also, high prices for rubber and palm oil induced farmers, particularly in the south and northeast, to switch to these two crops. It is important to note that switching from annual to perennial crops reduces the farmers' flexibility to adjust to external factors, and hence exposes them to higher climate change risks.

In addition to the climate, other causes of risks to farmers are changes in agricultural land use, land degradation and infertile land. More than half of all agricultural land in Thailand have saline, sandy, shallow or acidic soils (Table 5). These areas have low productivity and have restricted ability to adapt to climate changes.

Tables 6 and 7 show the impacts of climate change and variations in climate conditions on agriculture, especially floods and droughts. It is noted that floods and droughts can occur within the same year, although droughts are more common and more frequent than floods. This is due partly to highly intensive land use and partly to different rainfall patterns and physical characteristics in different regions throughout the country. During 1992-2002, there were more areas affected by frequent flooding (Table 6). The extent of damage varies from year to year, sometimes reaching hundreds of million dollars and affecting more than 2 to 3 million households (Table 7).

Table 4 Land Use in Thailand, 1987-2005

Year	Total land	Forest land		Agricultural land		Others	
	mil.ha.	mil.ha.	%	mil.ha.	%	mil.ha.	%
1987	51.312	14.606	28.47	20.992	40.91	15.714	30.62
1992	51.312	13.494	26.3	21.128	41.18	16.688	32.52
1997	51.312	13.030	25.4	20.978	40.88	17.304	33.72
1998	51.312	12.971	25.28	20.862	40.66	17.475	34.06
1999	51.312	12.898	25.14	21.014	40.95	17.398	33.91
2000	51.312	17.011	33.15	20.992	40.91	13.309	25.94
2001	51.312	16.102	31.38	20.970	40.87	14.238	27.75
2002	51.312	17.011	33.15	20.942	40.81	13.358	26.03
2003	51.312	17.011	33.15	20.909	40.75	13.392	26.1
2004	51.312	16.758	32.66	20.877	40.69	13.675	26.65
2005	51.312	16.758	32.66	20.845	40.62	13.709	26.72

Table 5 Land with Problematic Soils in Thailand, 2004

Problematic Land	Area (ha)
1. Saline soils	721,920
2. Sandy soils	2,043,173
3. Shallow soils	6,938,499
4. Acid sulfate soils	881,623
5. Organic soils	42,456
6. Slope complex	15,361,117
7. Acid soils	15,749,199

Source: Land Development Department

Table 6 Flood damages by provinces, aquaculture, and agricultural Land, 1989 – 2008

Year	Provinces (number)	Fish and shrimp ponds (number)	Agicultural land (ha.)
1989	52	112,650	1,623,305
1990	58	26,580	360,960
1991	66	24,500	1,580,004
1992	66	35,620	2,287,680
1993	42	42,560	2,563,881
1994	74	33,250	2,240,041
1995	73	124,560	606,778
1996	74	45,678	3,362,313
1997	64	32,560	1,963,042
1998	65	20,154	74,572
1999	69	32,658	486,107
2000	62	91,520	1,654,493
2001	60	36,589	4,661,402
2002	72	103,533	1,669,618
2003	66	22,339	255,289
2004	59	12,884	527,797
2005	63	13,664	272,232
2006	58	122,123	1,049,687
2007	54	13,866	258,765
2008	65	87,413	1,054,505

Source: Department of Disaster Prevention and Mitigation, Ministry of Interior

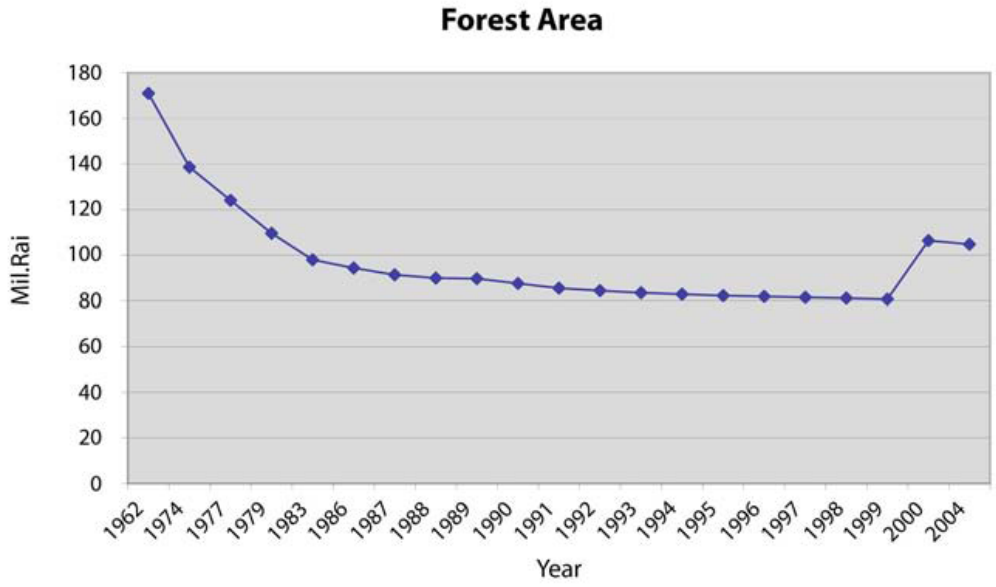
Table 7 Drought damages by provinces, residences and agricultural land, 1989-2008

Year	Provinces	Population	Household (number)	Agricultural land (ha.)	Damages (US$)
1989	29	1,760,192	496,062	207,078	3,752,822
1990	48	2,107,100	536,550	315,312	2,836,018
1991	59	4,926,177	1,221,416	165,963	8,066,774
1992	70	8,100,916	2,430,663	853,515	5,420,928
1993	68	9,107,675	2,533,194	326,471	6,115,697
1994	66	8,763,014	2,736,643	2,867,811	3,038,836
1995	72	12,482,502	2,661.678	480,230	5,465,244
1996	61	10,967,930	2,277,787	16,304	8,897,354
199	64	14,678,373	3,094,280	229,007	7,666,467
1998	72	6,510,111	1,531,295	286,286	2,128,311
1999	58	6,127,165	1,546,107	503,189	46,784,635
2000	29	10,561,526	2,830,297	75,632	19,745,011
2001	51	18,933,905	7,334,816	274,031	2,214,245
2002	68	12,841,110	2,939,139	331,450	15,654,829
2003	63	5,939,282	1,399,936	77,470	5,363,982
2004	64	8,388,728	1,970,516	236,833	5,866,735
2007	71	11,147,627	2,768,919	2,197,866	232,795,727
2006	61	11,862,358	2,960,824	92,600	15,239,253
2007	66	16,754,980	4,378,225	216,019	6,101,684
2008	61	13,298,895	3,531,570	84,000	3,196,949

Source : Department of Disaster Prevention and Mitigation, Ministry of Interior **Note :** US$ 1 = 32.5 Baht

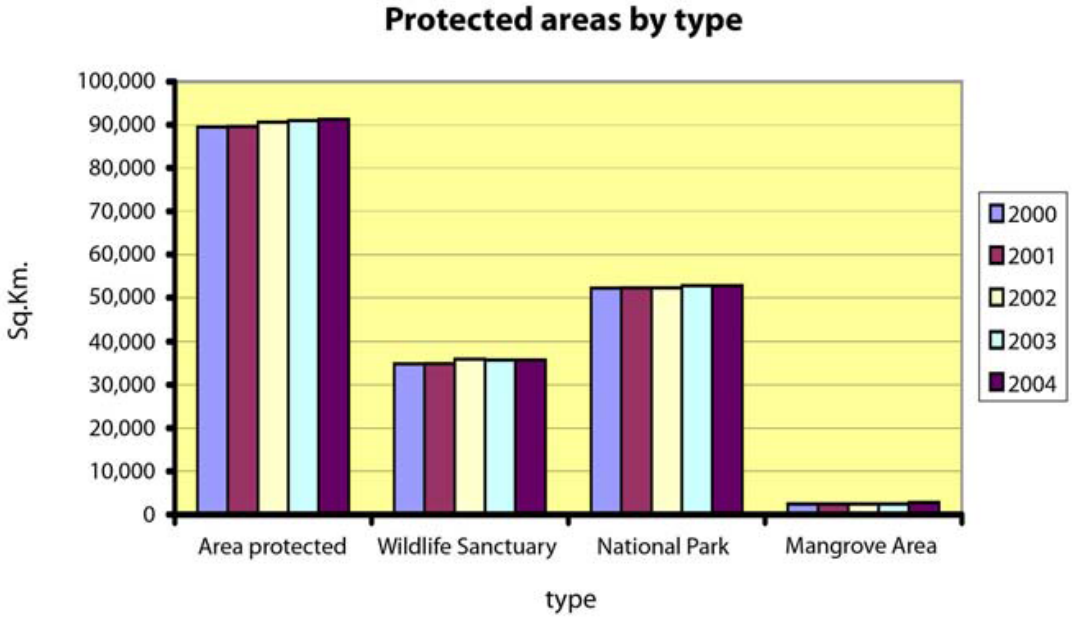
Forest Resources

A natural resource that is vital to humans in various ways, the forest is a source of food, raw materials, and a variety of products and services. It is a part of the ecosystem that is needed for human survival. Forest areas in Thailand have gradually declined and have been relatively stable only in the 1990s due to strong measures implemented by the Thai Government, particularly those that banned logging and expanded forest conservation areas (Figures 2 and 3).



Source: Royal Forest Department

Figure 2 Forest Land in Thailand, 1962-2004



Source: Department of National Parks, wildlife and Plant Conservation

Figure 3 Conserved Forest (by type), 2000-2004

In the early years of 2000, forest land was redefined and forest areas were adjusted accordingly. In 2004, Thailand's forest areas of 16.8 million hectares accounted for about 33% of the total land area. Most of the forest areas are in the northern and western parts of the country, although there are some along the southern peninsula. Northeast Thailand has the least conserved forest areas of all (Figure 4).

Source: Department of National Parks, wildlife and Plant Conservation, 30 November, 2007
Figure 4 Forest Land Distribution in Thailand, 2004

Due to exploitation, Thailand's mangrove forest was reduced from nearly 320,000 hectares in 1975 to less than 200,000 hectares in 1987. In 1996, the Thai Government decided to revoke all mangrove forest concessions and to rehabilitate these areas. In 2000, Thailand's mangrove forest covered over 250,000 hectares and increased to 275,000 hectares in 2004. The importance of mangrove forest has never been more recognized than during the tsunami tragedy in 2004. Areas sheltered by mangrove forests were saved from

the devastating effects of the tsunami, while those without such shield were completely destroyed.

Encroachment into terrestrial and mangrove forests continues despite efforts to protect them and the lessons learned from the tsunami tragedy. Management problems remain due to the followings:

- Industrial and urban expansion and infrastructure development
- Continuing deterioration of natural resources
- Lack of efficient mechanism to manage natural resources and the environment.
- Application of constitutional rights to protect natural resources, the environment, culture and quality of life While these factors often lead to more systematic and efficient management of natural resources, such as integrated management of watershed areas and resource watch network, they also have the potential to aggravate conflicts, as seen in the case of coal power plants. Thailand still needs to develop a more efficient natural resource and environmental management mechanism. A key factor contributing to such a mechanism is the application of conflict management, based on a system for good governance.

Water Resources

Thailand has 25 watershed areas across the country **(Table 8).** Some 6.4 million hectares are irrigated and 14.6 million hectares are rainfed. Average rainfall ranges between 1,400 and 1,600 mm./year **(Table 9).** The amount of rainfall exceeds 800 billion cum./year. By region, average rainfalls in the north, northeast and central regions are lower than the average, while those in the east and south are higher than the average **(Table 9).**

Of the 800 billion cum./year of rainfall, only about 200 billion cum. is surface water that is available for utilization. Total water storage capacity, by different types of dams and reservoirs, is about 74 billion cum. (Table 1-10). However, water in the reservoirs for the summer season is only about 45 billion cum.5. Most of the water is stored in large and medium size reservoirs which account for over 90% of storage capacity in the country.

Table 8 Watershed areas, rainfall and surface water flow (by region), 2001

Region	Watershed (number)	Sub-watershed (number)	Watershed area (sq.km.)	Rainfall (mil.cum.)	Ave. surface water flow (mil.cum.)
North	6	70	128,450	213,412	39,748
Northeast	3	68	176,599	237,578	54,290
Central	5	39	86,128	85,259	24,009
East	4	26	36,480	76,363	23,455
South	7	53	84,450	162,927	67,767
Total	25	256	512,107	775,539	209,269

Table 9 Average annual rainfall (by region) 1995-2004

Region	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
North	1,349.5	1,360.2	1,094.1	1,012.8	1,339.0	1,334.1	1,376.8	1,469.0	1,073.5	1,258.2
Central	1,335.0	1,493.9	1,005.6	1,368.8	1,501.7	1,341.4	1,238.7	1,241.2	1,252.4	1,009.2
East	2,082.5	1,819.9	1,589.1	1,779.7	2,051.0	1,998.5	1,761.5	1,665.2	1,757.2	1,550.5
Northeast	1,408.5	1,520.5	1,308.9	1,186.7	1,540.6	1,671.7	1,488.6	1,620.3	1,314.5	1,406.8
South (East coast)	1,754.7	2,062.5	1,693.7	1,718.3	2,237.2	2,281.2	2,015.6	1,587.3	1,784.9	1,408.2
South (Went coast)	2,861.5	2,704.1	2,384.9	2,795.3	3,026.0	2,808.8	2,958.9	2,361.2	2,689.6	2,413.8
Total	1,686.5	1,734.3	1,432.3	1,050.4	1,829.6	1,813.0	1,707.3	1,607.9	1,525.9	1,438.3

While storage capacities and water supply are restricted by physical and natural characteristics, the demand for water continues to increase due to population growth and economic development **(Table 10).** It is projected that by 2021 or within the next decade, the demand for water will reach 120 billion cum. This projected demand, unless properly managed, would pose a serious threat to social and economic development.

Fluctuations in the natural supply of rainwater and limited storage capacities affect rainfed and irrigated agriculture. Climate variability brings about fluctuating rainfalls that cause droughts and floods across regions. This situation has called for a classification of drought- and flood prone areas and adoption of special measures (Table 1-12). Most cases of severe droughts occur in the north and northeast regions, which account for over 80% of the country's drought-prone areas and nearly 80% of areas that are prone to severe droughts. In 2005, Thailand suffered the most severe drought, especially in the eastern region where the largest industrial estate and fruit orchards are located. Water shortage necessitated short, medium and long term measures.

Table 10 Water demand (by sector and region) (mil. cum)

Region	Consumption		Industrial		Irrigation		Eco maintenance		Total	
	2001	2021	2001	2021	2001	2021	2001	2021	2001	2021
North	226	243	108	260	7925	14,637	4,332	4,332	12,593	19,471
Northeast	548	621	297	584	7,989	44,228	2,783	2,783	11,617	48,226
Central	1,355	1,580	784	2,270	23,534	29,988	5,836	5836	31,509	39,673
South	233	308	127	327	1836	9052	9,139	9,139	11,335	18,826
Total	2,363	2,753	1,316	3,440	41,284	97,904	22,090	22,088	67,053	12,6196

Source: Office of Natural Resource and Environmental Policy and Planning

Table 11 Drought-persistent areas in Thailand (by region, level and frequency)

Level of frequency	North	Northeast	East	Central	South	South	Percent
Highly severe	10,519,595	26,572,673	146,142	4,755,300	-	43,307,10	72.27
Moderately severe	77,994	8,385,481	760,930	6,652	718	9,294,775	15.51
Less severe	31,188	5708,256	1,433,361	84,556	66,556	7,323,926	12.22
Total	10,628,777	40,66,410	3,654,433	4,909,517	67,274	59,926,411	100
percent	17.74	67.86	6.10	8.19	0.11	100	

Source: Office of Natural Resource and Environmental Policy and Planning

Thailand has prepared a water resource development strategy that emphasizes:

- Development of an integrated management mechanism with public participation at all levels
- Improvement of conservation, rehabilitation and utilization of water resources, consistent with the ecological system in the area
- Development of a participatory water watch and an early warning system

It is expected that implementation of the strategic plan will require an investment of more than US$ 86 million. It is noted that most of the investment is supply enhancement-oriented.

Under conditions of limited water supply and excess demand for it, global warming and climate change are additional factors that could either aggravate or improve these conditions, depending on their effects. Nevertheless, going by general trends of more

frequently occurring severe drought in the hot season, it is likely that climate variability would do more harm than good. More technical and systematic analysis is needed to better understand and predict the potential effects.

b. Major resource degradation problems:

Land degradation means reduction or loss, in arid, semi-arid and dry sub-humid areas, of the biological or economic productivity and complexity of rainfed cropland, irrigated cropland, or range, pasture, forest and woodlands resulting from land use or from a process or combination of processes, including processes arising from human activities and habitation patterns, such as;

(i) Soil erosion caused by wind and/or water;
(ii) Deterioration of the physical, chemical and biological or economic properties of soil; and
(iii) Long-term loss of natural vegetation

The major causes of degradation found in Thailand are: (a) climatic factors i.e. heavy rain during the monsoon period dissolves and translocates soil minerals and seasonal drought; (b) human activities i.e. land use without soil improvement, over-exploitation of land, land use on steep-slope lands causing soil erosion and expansion of saline soil.

Soil erosion by water : Soil erosion causes land degradation due to loss of surface soil and plant nutrients. Agricultural land will no longer be suitable for continuous use without protection and/or improvement.

Regarding the application of the Universal Soil Loss Equation (A=RKLSCP), the following amount and severity levels of soil loss are found in Thailand.

Lowland (alluvial plain, footslope, hill less than 35 per cent slope)

Soil loss classes	Areas (hectare)
Class 1 :slightly	27,235,036
Class 2 :moderate	6,865,991
Class 3 :severe	1,566,276
Class 4 :very severe	110,352
Class 5 :extremely severe	363,414
Total(1)	36,141,069

Highland (mountainous slope, valley slope, more than 35 per cent slope)

Soil loss classes	Areas (hectare)
Class 1 :slightly	6,656,164
Class 2 :moderate	4,114,024
Class 3 :severe	2,277,102
Class 4 :very severe	426,813
Class 5 :extremely severe	1,696,329
Total (2)	15,170,432
Grand total(1+2)	51,311,501

As can be seen from the above figures, lowland contains 8,906,033 hectares of area under soil loss, including moderate up to extremely severe, beyond the permissible level or more than 12.5 ton/hectare/year. On mountainous land, the total area including moderate to extreme soil loss is 8,514,268 hectares.The total area of soil loss in the country, including moderate to extreme levels on both lowlands and highlands, is 17,420,302 hectares or 33.9 per cent of the country area.

Declining of Forest areas : Forest area in Thailand was 27.36 million hectares or 53.3 per cent of the country in 1961 and 12.96 million hectares or 25.28 per cent by 1998. Declining forest area directly contributes to land degradation on slopping land and headwater regions due to occurrence of soil erosion. It is evident in 5.2 that a total of 8.51 million hectares under moderate to extremely severe levels of soil loss occurred on highlands. In addition, loss of forest area also contributes to the expansion of saline in the North-east region.

Problem soil for Agriculture : Seven types of problem soil for agriculture in Thailand can be classified ie. saline soil, acid sulfate soil, organic soil, very sandy soil, sandy soil, shallow soil. And soil on slop complex areas. These soils make up 33,575,602 hectares of land within the country as given below.

(1) Saline soil, sodic saline soil and affected areas: 3,475,044 hectares
(2) Acid sulfate soil: 667,358 hectares
(3) Organic soil: 43,884 hectares
(4) Very sandy soil: 1,115,747 hectares
(5) Sandy soil: 6,336,219 hectares
(6) Shallow soil: 6,555,547 hectares
(7) Soil on slope complex area: 15,381,842 hectares

Desertification : In order to respond to adjacent programmes , the analysis of desertification in Thailand covers four important areas as follows:

(1) Identification of aridity index using the ratio of average annual rainfall over potential evapotranspiration
(2) Soil erosion by water,
(3) Loss of forest area, and
(4) Problem soils

As can be seen from the above data , desertification in Thailand is caused by soil erosion, reduction of forest area and land degradation due to land-use problems. More over, the ratio of average annual rainfall over potential evapotranspiration shows that some areas of the country fall within the dry sub-humid climate classification.

c. **Climate change and role of climate change:**

Potential climate change in Thailand is seen in downscaled scenarios based on IPCC's emission scenarios. Previous studies in Thailand suggested high uncertainties among different GCMs, requiring urgent improvement in this regard21. Over the past decade, several research studies on climate change have contributed to the understanding of climate change and its potential effects, as summarized belows:

Agriculture: Despite the declining ratio of agriculture to the gross national product, more than half of the population is engaged in agriculture, where incomes are relatively low. Agriculture remains as one of the key sectors in the country's economic and social development and is also the source of raw materials for various downstream industries. During the economic crisis in 2000 and 2007, agriculture provided food security and was an important source of employment.

Climate change affects agriculture in different ways depending on the direction and magnitude of change. Early studies on the impact of climate change on rice and maize yields, using different models in selected areas, found that crop yields varied substantially. The uncertainties were too high to be used in policy formulation. Although climate models have

been refined continuously, problems of high uncertainties remain in the analysis of climate change impacts on agriculture.

A recent study on the impacts of climate change on agriculture applied scenarios generated using a regional climate model. The results indicated moderate, if not minimal, potential impacts on rice, maize, sugarcane and cassava production. The potential impacts on yield fluctuation or variability tend to be substantial, however. The north of Thailand tends to have higher production risks in the rainy season compared with other regions. Potential impacts during the hot season are similar across Thailand. Because only one model was used, uncertainties remained as an issue.

In addition to the issue of uncertainties, another key weakness of earlier studies is the lack of socio-economic scenarios. The latest study attempted to develop socio-economic scenarios based on Thailand's development vision for the next 20 years. Three possible scenarios were developed:

- Emphasis on food production (World Kitchen)
- Emphasis on renewable energy
- Emphasis on integration of 1 and 2 and the demand for eco-balanced development

Each scenario will have different land uses for agriculture and other activities. Under the natural resource constraints, emphasis on food production will enhance rice production by 23%. Under the renewable energy policy, sugarcane and cassava areas will double. Under the integration policy, conserved forest areas will increase, and the agricultural system will take into consideration soil and water conservation.

Water resource: Climate change affects two aspects of water resources, that is, surface water flow and water storage. The key determinants are the amount and intensity of rainfalls and the rate of evaporation.

Studies on the impact of climate change on surface water flow into the Bhumibhol and Sirikit dams, based on climate scenarios from CCAM and a hydrological model called VIC (Variable Infiltration Capacity), found that climate change could reduce water flow into the Bhumibhol dam by the middle of the century. However, there were no impacts on the Sirikit dam. By the end of the century, water flow into the two dams is expected to increase substantially due to the impact of climate change.

Studies on water resources in the Mekong River based on several climate models found that surface water flow tends to increase due to increased rainfall. The higher the CO2 concentration, the heavier is the rainfall. However, during the dry season, water flow will be lower than normal. It is notable that the models used in this study indicated the same positive impacts on water resources, including potential flash floods in the eastern region.

Health : The first study on climate change impacts on health in Thailand was in the Initial National Communication. A technical relationship between temperature and the growth rate of mosquitoes was used. It was concluded that global warming will enhance the potential spread of malaria within the first half of the century.

Forest and wildlife : There has been no study on climate change impacts on forests since the study covered in the Initial National Communication. The main potential impacts are expected to affect the type and structure of the forest, forest ecosystem, and biological diversity of fauna and flora. Biological diversity of fauna and flora is vital to the development of agricultural genetic resources. These issues are addressed in strategies contained in the National Strategic Plan on Climate Change (2008-2012), to adapt to climate vulnerability.

Marine and coastal resources : Thailand's coastline is more than 2,600 kilometers long and is blessed with an ecosystem that is highly important to the social and economic development of the southern and eastern regions. Studies on the potential impacts of sea level rise due to global warming have been limited. A small study in Krabi province using DIVA (Dynamic Interactive Vulnerability Assessment) shows that the sea level along the coast of Krabi will rise by 11 to 22 cms. in 25 to 30 years due to global warming. About 10 to 35 meters of the coastline will be inundated.

Climate variability and extreme events : Climate variability and extreme events, especially droughts, floods and storms, have intensified due to global warming. Such natural disasters have caused substantial damage to food production and rural livelihoods, as well as to the country's national economic and social development (Table 3-2). Several studies have analyzed past events and have provided a forecast for the future. Recognizing the importance of adaptation to increasing climate change variability and extreme events, Thailand has conducted a pilot study in Kor Tao (Tao Island), Surat Thani province. Historical data and 30-year scenarios using a climate model indicated that a slight increase in the number of monsoon days. Using the historical data to forecast future trends, it was found that the frequency of depressions is likely to decrease, typhoons are likely to increase, and monsoon storms will see no change.

An estimated 20 cm. rise in the sea level around the island will affect the stability of coastal areas by 5-20 meters. Based on the potential effects of storms and the rise in the sea level, researchers carried out consultations with the local community and together drew up community development scenarios over the next 30 years. After a series of consultations, different adaptations were considered and evaluated. The meeting concluded that green development will be the best option to enable the community to respond positively to global agreements on the environment. The option will also enable the community to effectively cope with risks due to global warming and to pursue the path towards sustainable development.

Technical and Management Issues on Vulnerability and Adaptation : The above provides a broad picture of progress concerning vulnerability and adaptation studies over the past decade. In general, V&A studies in Thailand are still at an early stage of development, in the midst of increasing impacts and vulnerability to climate change and climate vulnerability and extreme events. The main issues that need to be addressed are, as follows:

- Uncertainties in downscaling the global climate change scenarios to national and regional scenarios
- Meaningful behavioral linkages between climate factors and key sectors of the economy, such as climate change and cash crops, paddy and fruit trees
- Socio-economic scenarios for vulnerability analysis in all sectors
- Integration of vulnerability and adaptation strategies into different sectors and stakeholders Innovative technical approaches that rapidly and meaningfully respond to policy needs, in order to address increasingly severe effects of climate change and climate vulnerability and extreme events.

The aspect of natural resources and the environment Natural resources have been depleted and the environment has been degraded. Moreover, climate change has exacerbated problems involving natural resources and the environment, and has affected agricultural production and poverty. Management of natural resources and the environment has not been effective and the conflict between environmental conservation and economic development has been made manifest. Nonetheless, Thailand's food security

has remained adequate despite challenges from climate change and from increasing demand for fuel crops.

III. Barriers to adoption of soil and water conservation (SWC):

Constitution of the Kingdom of Thailand B.E. 2540:

Section 79. The State shall promote and encourage public participation in the preservation, maintenance and balanced exploitation of natural resources and biological diversity and in the promotion, maintenance and protection of the quality of the environment in accordance with consistent development principles as well as the control and elimination of pollution affecting public health, sanitary conditions, welfare and quality of life.

Section 84. The State shall organize the appropriate system in holding and use of land, provide sufficient water resources for farmers and protect the interests of farmers in the production and marketing of agricultural products to achieve maximum benefits, promoting the assembling of farmers with a view to laying down agricultural plans and Vision, Missions, Objectives and Targets of the Eleventh Plan (2012-2016) protecting their mutual interests.

Vision, Missions, Objectives and Targets of the 11th National Economic and Social Development Plan (2012-2016) :

The Eleventh Plan is an interim medium-term strategic plan to pursue the vision for the year 2027 that was set by all parties in Thai society. It states that "Thai people are proud of their national identity, in particular their hospitality. They also follow the path of Sufficiency Economy with democratic values and good governance. Quality public services are provided throughout the country. Thai people live in a caring and sharing society in a safe and sound environment. Production processes are environmentally sound, and food and energy resources are secure. The economy is based on self-reliance, and on increasing links and competitiveness in the global market. Thailand has actively contributed to the regional and world community with dignity."

Vision and missions : The Eleventh Plan is the first step toward the long-term vision of 2027. For the next five years, the vision and missions are established as follows:

Vision "A happy society with equity, fairness and resilience."

Missions :

1) To promote a fair society of quality so as to provide social

protection and security, to enjoy access to a fair judicial system and its resources, and to participate in the development process under good governance.

2) To develop people with integrity, knowledge and skills appropriate to the age of each, and to strengthen social institutions and local communities to ensure positive adaptation to changes.

3) To enhance the efficiency of production and services based on local wisdom, knowledge, innovation and creativity by developing food and energy security, while reforming the structure of economy so that consumption becomes more environmentally friendly, and strengthening relations with neighboring countries in the region for economic and social benefits

4) To build secure natural resource and environmental bases through supporting community participation and improving resilience that will cushion impacts from climate change and disasters.

Objectives and targets

Objectives

1) To promote a fair and peaceful society.

2) To increase the potential of all Thais based on a holistic approach that enables physical, mental, intellectual, emotional, ethical and moral development through social institutions.

3) To develop an efficient and sustainable economy by upgrading production and services based on technology, innovation and creativity using effective regional links, by improving food and energy security, and by upgrading eco-friendly production and consumption toward a low-carbon society.

4) To preserve natural resources and the environment so they are sufficient to maintain ecological balance and a secure foundation for development.

Main targets

1) Thai society will become a better place, characterized by harmony and the well-being of its people, where inequality is decreased, the number of people beneath the poverty line is reduced, and the Transparency International (TI) Corruption Perception Index scores at least 5.0.

2) All citizens will acquire lifelong learning opportunities and better health, while social institutions are strengthened.

3) The Thai economy is expected to provide inclusive growth at a moderate pace based on its potential by upgrading total factor productivity (TFP) to at least 3 percent per annum, by improving Thailand's competitiveness rank, and by increasing the contribution of SME's to at least 40 percent of GDP.

4) Environmental quality will be improved to meet international standards, reduction of greenhouse gas emissions will be more efficient, and forest areas will be expanded to restore balance to the ecology

The 11th Plan emphasized the management of natural resources as follows.

Objectives

(1) To focus on the management system based on shared responsibility, transparency and practicability. Knowledge and information shall be disseminated to people, community, and local administrative units, so that they can actively participate in protecting natural wealth.

(2) To restore a proper balance using, preservation, and rehabilitation of natural resources. Effective controls over resource use shall be instituted. Environmental quality shall be improved in order to promote a grassroots economy and quality of life. Also, top priority shall be given to the management of livable environmentally healthy cities and the preservation of local culture and arts.

Targets

To preserve and rehabilitate natural resources consistent with sustainable use. Forest reservation shall cover an area not less than 25 per cent of the entire Kingdom, while

mangrove forest shall cover an area no less than 0.2 million hectares. By 2006, soil erosion reduction measures shall be undertaken on no less than 0.8 million hectares, and rehabilitation measures to address problems of soil quality, such as soil acidity, soil saline, and infertility, shall be undertaken on no less than 1.6 million hectares.

Development Guidelines

(1) Upgrading the efficiency of natural resource and environmental management to induce conservation, rehabilitation, and development of grassroots economy.

(2) Preservation and rehabilitation of natural resources of the country for better ecosystem balance, and supporting grassroots economy.

Government Policy: The Government's policy stated on Monday 26, February 2001 on income creation policy part 1 as follows:

"Supporting farmers to have adequate land for earning their livelihood by implementing a coordinated and comprehensive land utilization policy and by optimizing the use of idle land. The management of water resources at every level must also be improved efficiently in a manner that is suited to the production system of each crop and the conditions of the terrain. Emphasis must be placed on the full participation of the people in the restoration, conservation and development of land that is upstream as well as in river basins, reservoirs, irrigation canals, water quality, and piped irrigation. The use of surface water and underground water must also be efficient and systematic, especially in projects involving the development of large water sources."

Strategic Plan of the Ministry of Agriculture and Cooperatives

A strategic plan of the Ministry of Agriculture and Cooperatives, of which the National Action Programme for Combating Desertification is constituted, consists of the following details;

Vision

A principal ministry producing agricultural products meeting consumer safety standards worldwide as well as protecting the well-being of local farmers.

Mission

i. Conduct research and development, and transfers agricultural technology.
ii. Develop infrastructure for agriculture.
iii. Promote universal standard production, and
iv. Promote and strengthen farmers' intuition and self-reliance for improved quality of life and sustainable livelihood.

Goals

i. Agriculture production in responding with marketing demands and safety for consumers, and
ii. Improved quality of life and well-being of famers.

Strategic issues and strategies

Two strategic issues and strategies prepared by the Ministry of Agriculture and Cooperatives in responding with the National Agenda and Government Policies to achieve the above goals offer the following details:

Strategic issues

i. Strategic issues 1. Agriculture production will be focused on the improvement of performance for competitiveness by development of substantial infrastructure for agriculture eg. land, water, and etc. Up-to-date technology and know how will be brought in to improve productivity in order to achieve anticipated quality and safety, as well as higher price. Aiming to achieve value added agricultural and food products directly serving market demand, productivity development and transformation as well as packaging will be applied whereas a unique brand name will be publicized globally.

ii. Strategic issue 2. As a prime concern, the Ministry of Agriculture and Cooperatives will prioritize living conditions of farmers at all levels especially small-scale and landless farmers who have no land for cultivation. More options will be generated through to access formal sourced of funding, promotion of local knowledge and know-how, and recuperation of farmers' livelihood to earn enough for a sustainable living.

The NAP combat desertification will be a component of the strategy to increase productivity including the development of basic resource infrastructure for production as follows:

"At present, most farmers have not enough water for agriculture. In some areas, they are facing drought and marginal soils. These resources are fundamental costs of production. To help farmers produce efficiently, there is a need to develop resource infrastructure for such areas to meet maximum capacity. The infrastructure must be equally distributed and allocated to farmers in all areas. Management must also be applied to protect these production resources from natural hazard. Irrigation systems and wells must be provided in drought prone areas. Soil Fertility must be developed, maintained and improved for better productivity and sustainable use. "**Implementation of the National Action Programme to Combat Desertification is a part of this strategy"**

IV. Best/appropriate management practices :

Watershed Management : focus that the Royal Thai Government has taken is very much to start from the angle of upper watershed management and then see what the implications are for downstream development, agricultural, industrial and urbanisation. Indeed, although comprehensive river basin management is envisaged as the ultimate goal, it is the term watershed management-implying an emphasis on conservation and reforestation of the upper reaches of the river-which is the focus of the initial system.

In the course of the project, watershed classification of the entire country was carried out, and was completed and approved for implementation by the Cabinet, region by region, between 1985 and 1995. The total land area was divided into watershed classes (WSC) 1-5, defined as follows.

WSCI is divided into classes l A and l B. Class l A comprises protected forest and headwater source areas. These areas are usually at high elevations with very steep slopes, and should remain as permanent forest cover. Class 1B has similar physical and environmental features to class l A, but portions of the area have been cleared for agriculture or occupied by villages. These areas require special soil conservation and protection measures, and where possible forest should be replanted or permanent agroforestry should be practised.

WSC2 represents areas of protection and /or commercial forests. Logging and mining can be allowed within legal boundaries. Landforms are less subject to erosion than WSCIB. Areas may be used for grazing or production of certain crops if accompanied by appropriate soil protection measures.

WSC3 covers upland areas with steep slopes, but a less erodible landform than WSC2. These areas may be used for commercial forest, grazing, fruit trees, or certain crops with appropriate soil conservation measures.

WSC4 represents areas of gently sloping land suitable for arable crops, fruit trees and grazing, with moderate need for soil conservation measures. WSC5 comprises gentle slopes to flat areas used for paddy fields or other intensive agricultural uses, with few restrictions.

By 1987, Watershed classes 1 and 2 had been endorsed by the Cabinet as areas to be highly protected and rehabilitated as river headwaters. In particular, watershed class l A was designated to be protected from any use of natural resources except for purposes of forest and ecological rehabilitation. All residents occupying these areas were to be evacuated and relocated. These areas are usually at higher elevations with steep slopes, and are designated to remain as protected forest areas and sources of water supply.

A major objective of the watershed classification project was to formulate land use plans for the conservation of natural resources, and in particular water resources with a view to their sustainable use. The classification takes into consideration physical characteristics, including stable features such as landform, geology, soil, elevation and slope. Forest cover and environmental features of landscape units which are less stable and interact with climatic trends and human uses are also considered.

Various methodologies were examined for generating watershed classification maps and the following system was eventually adopted. A 1 km^2 grid was adopted as the basic classification unit, being small enough to be useful for land use planning purposes but not so small that the data processing requirements would become difficult to handle. The basic assignment of watershed values was the result of a calculation for each 1 km^2 'cell' arrived at using information from topographical. soil, geological and forest maps.

Slope Agricultural Land Technology (SALT): SALT is a technology package of soil conservation and food production that integrates several soil conservation measures. Basically, the SALT method involves planting field crops and perennial crops in bands 3-5 m wide between double rows of nitrogen-fixing shrub SALT is a package technology on soil conservation.

"SALT" and food production, integrating different soil conservation measures in just one setting . Basically, SALT is a method of growing field and permanent crops in 3-meter to 5-meter wide bands between contoured rows of nitrogen fixing trees. Are thickly planted in double rows to make hedgerows. When a hedge is 1.5 to 2 meters tall, it is cut down to about 40 centimeters and cuttings (tops) are placed in alleyways to serve as organic fertilizers.

Protection and restoration of natural resources and the environment : These have led to increased biodiversity. A campaign to expand mangrove areas and grow community, demonstration, and private forests, together with conservation efforts, increased forest area from 32.7 percent of the country in 2006 to 33.6 percent in 2010. Similarly, irrigation development projects of various sizes and Kaem-Ling reservoirs increased irrigated areas to 29.3 million rai in 2010. However, improvement of soil quality did not reach its target. Carbon dioxide emissions increased. Water resources deteriorated. Water quality in the principal rivers also declined. Water resources of fair quality or 3 higher decreased from 74 percent in 2006 to 61 percent in 2010. Furthermore, the control of toxic chemicals was inefficient. Sanitary handling of infected waste also failed to meet the target and resulted in higher pollution. Therefore, natural resources require better restoration and preservation efforts, along with more effective pollution control and improved environmental quality in order to create a stable foundation for the country's development and provide a sustainable daily life for the people.

V. National action programs on soil and water conservation:

National Action Programme : Considering the designation to combat desertification by the Ministry of Agriculture and Cooperatives, the LDD prepared this National Action Programme to serve as a response with the mentioned Policy of State. The Programme includes the Constitution of Thailand of the 11th National Socio-economic Development Plan, to develop production infrastructure to increase productivity of the Ministry of Agriculture and Cooperatives. Detail of the Nap is given below.

Vision

Land Development Department is a key agency to conserve and rehabilitate land resource fertility in supporting safety, security and sustainability for food production of the country.

Missions

(1) Issues of suitable land-use zones for production as well as provide services of accurate and up to date spatial date;
(2) develop and implement soil and water management in supporting safety and security for incremental crop production;
(3) Conducts research and development and transfers technologies concerning management of land, water, crops, organic fertilizer, as well as thoroughly distributes useful micro-organisms for agriculture to farmers.

Goals

(1) Good quality soil and water resources for agriculture, and
(2) Increased opportunity to access to land development services.

Indicators

(1) No less than 20 zones of suitable land for cropping,
(2) 16 million hectares of cultivated area will be developed,
(3) 200,000 site water resources in rainfed areas will be increased,
(4) All volunteer soil doctors will be strengthened and readily knowledgeable to service all sub-districts and villages
(5) Farmers can access 7,125 learning and service centers of all sub-districts, and
(6) 80 per cent of users will be appreciated with services provided by LDD

Strategic issues and strategies

To achieve the vision, missions and targets of each key agency to conserve of soils and water resources for crop production that aims to promote suitable land uses as well as the National Action Programme to Combat Desertification, the LDD defined two groups of offensive strategic issues, consisting of 4 strategies for implementation, as follows:

Strategic issue 1: Development of basic infrastructure of soil and water resources for crop production that aims to promote suitable land uses as well as improves soil fertility and water resources to achieve safety and security, increasing crop production while reducing production cost competitiveness and conserving the environment. Two strategies have been initiated below.

Strategy 1: Development of geo-information technology (GIS) as well as delineation of agricultural land-use zones for suitable and appropriate use of land while reducing production cost by the following guidance.

(1) Development of soil information and maps by acceleration of soil surveys and classification activities for 1:25,000 mapping scales throughout the country. The improved detailed map will support and enhance more accurate and up to date soil analysis. Aerial photo and a ortho-color map of the Ministry of Agriculture and Cooperatives will be produced at 1:25,000 and 1:40,000 mapping scales to support urgent of specific programmes and agencies for example the Conversion of Asset to Capital Programme, the Sea Food Bank Programme, etc.

(2) Planning and delineation of suitable soil boundaries for individual crop and crop varieties in addition to the major economic crop which have been implemented. These will support a strategy to the major economic crops which have been implemented. These will support a strategy to increase production of seven potentially exportable agricultural goods i.e. rice, para rubber, cassava, orchid, pineapple, tiger prawn, and chicken that the Ministry of Agriculture and Cooperatives will introduce to the world's Kitchens. Newly thirty-five potential agricultural good will be pushed forward for export. They include: six kinds of vegetable i.e. asparagus, roselle, baby corn, sweet corn, garden pea, bean, soil bean, vegetables; fourteen kinds of fruit i.e. fresh fruit, dry and dehydrated fruit, mangosteen, durian, longan, pamelo, yellow banana, banana, mango, coconut, lychee, pineapple, Sri Thong rambutan, Round Sali guava; Four kinds of Thai recipes i.e. chilli, galangal, tamarind, coconut milk; four kinds of herbs i.e. plai (*Curcuma Cassumunar*), turmeric, black kaempfer, amomum (*Siam Caramon*); three kinds of ornamental flower i.e. chrysanthemum, curcuma, anthurium, and others; four kinds of livestock animal i.e. native chicken, organic chicken, swallow, dove; and fishery i.e. ornamental fish, aquatic plant, accessories of ornamental fish aquarium.

(3) Monitoring of land use and assessment of crop productivity by conducting land-use surveys annually as well as applying ego-information technology for assessment of productivity of important economic crops which will be used to support planning for marketing by concerned agencies.

Strategy 2: Development of soil and water resources to increase productivity qualitatively and quantitatively for safety and security reasons. In order that farmers can increase their production while decreasing production cost. The development will cover 16 million hectares of cultivated areas. The following are the guidelines for implementation:

(1) Improvement of the system for land development by adopting a holistic approach. Activity areas will be focused on increasing soil reaction or pH and soil organic matter as well as protection of soil erosion and organizing diversified cropping systems. The following will be principle activities:

(i) **Activity to increase soil pH** by applying lime material such as grinding rock and marl to increase availability of plant nutrients while applying less chemical fertilizer.

(ii) **Activity to increase soil organic matter** by applying compost, green manure, organic fertilizer (LDD 1-7) and vetiver grass to keep soil moisture as well as increasing more air to the soils.

(iii) **Activity to prevent and protect soil erosion** by planting vetiver grass with the structures of soil conservation systems such as feeder roads that can be used for transportation of agricultural goods as well as function like dikes to divert water into sedimentation ponds or farm ponds available for further use. The structures will also be

useful for prevention of sedimentation and maintaining natural water resources when water storage capacities elsewhere are reduced.

(iv) **Activity to prevent cropping** by applying twice a year plantation, strip cropping, and multiple agriculture or New Theory agriculture to incomplete the life-cycle of insects and diseases while reducing risk of production and price;

(2) Specifying land development for individual crops to increase the efficiency of crop production and the land suitably and appropriately such as;

Rice:

- Stop burning of rice straw but burying and applying liquid organic fertilizer(LDD 2) with green manure for soil improvement,

- Raise soil pH in competitive agriculture areas to 6 or more and apply liquid organic fertilizer (LDD 2) in combination with LDD no.5 and LDD no7,

- Twice or three or three times a year cropping will be promoted in self-subsistence areas by rotation cropping or multiple agriculture or New Theory;

Cassava:

- Raise soil pH to 6 or more and apply green manure,
- Applying vetiver grass as intercropping with cassava on slopping land in competitive agriculture areas with provision of feeder roads and farm ponds while supporting utilization of liquid organic fertilizer(LDD2) and LDD5,
- Supporting alternate cropping and the New Theory Agriculture in self-subsistence areas

Sugar cane, corn and other field crops:

- Follow the line as applied to cassava considering suitability of specific areas

Horticulture, vegetables, orchards

- Focus on raising soil pH to 6 or more together with LDD compost (LDD1, 2, 3, 5, 7)

(3) Development of soil and water resources and promote utilization of organic fertilizer, bio-fertilizer and agricultural bio-organisms by:

(i) Rehabilitation and improvement of soil in areas where farmers growing economic crops can increase at least 10 per cent of production while decreasing 10 per cent of production cost and 30 per cent of chemical use by:

- Using appropriate fertilizer and soil amendment material to support crop production
- Supporting organic farming and production for food safety,
- Farmers will be promoted/encouraged to use organic fertilizer, bio-fertilizer, and products from agricultural micro-organisms for soil improvement, nutrient enrichment, prevention from harmful insects, and protection of the environment.

(ii) Implementation of soil and water conservation in necessary areas to protect against soil erosion, to conserve soil quality, to rehabilitate the environment, and to increase food security by: incorporation of vetiver grass plantation with establishment of soil and water conservation systems i.e. farm roads and farm ponds.

(iii) Provision of integrated water resource development to improve efficiency of soil and water conservation, water storage, that will provide enough water for a number of cultivation practices by farmers such as the New Theory Agriculture, mixed

farming, including mitigation and addressing problems of drought and flooding to sustain farming and to achieve uninterrupted crop production. The New Theory Agriculture will be supported and further enhanced into public schools as a source of lunch food for students.

(iv) Produce, develop and transfer innovative research and technologies concerning of soils, water, crops, and biotechnology to support an increase of qualified products and safe food production by:

- Transferring and enhancement of developed innovative technologies such a LDD 1 accelerating agent for producing compost, LDD 2 accelerating agent for producing liquid organic fertilizer, LDD 3 accelerating agent for producing micro-organisms to control plant disease, LDD 5 accelerating agent for producing weed control substance, LDD 6 accelerating agent for producing micro-organisms for waste water treatment, and LDD 7 accelerating agent to protect crops from harmful insects,

- Strengthening farmers to produce all LDD's accelerating agents for soil improvement for marketing as well as to create new innovative technologies as required by customers.

(v) Organizing public relations and extension for access by target groups.

Dissemination of land development information insights:

- different media such as publications, CD, and Website;
- establishment of continuous learning networks among volunteer soil doctors, farmers, and agencies for up to date, fast, and correct dissemination of innovative technologies;

(vi)Protection from landslides by: Mapping of landslide risk areas at 1:50,000 scale and establishment of warning system for farmers in such areas.

Strategic issue 2: Accessibility of farmers to land development service consisting of two strategies aimed at the enhancement of opportunity for farmers and communities to thoroughly access public services.

Strategy 1: Establish and develop Volunteer Soil Doctors, learning centers, and sub-district land development service centers to function as continuous learning and service networks by:

(i) Recruitment and development of sub-district and village volunteer soil doctors

- Recruit to complete a total number of 7,125 sub-district Volunteer Soil Doctors as well as 60,000 village Volunteer Soil Doctors to be the driving mechanism and network to quickly cooperate and help local farmers throughout the country on behalf of the LDD.

- Annually strengthen and develop know-how and experience to increase capacity of Volunteer Soil Doctors to be agricultural entrepreneurs, ready to provide services, and to make recommendation to farmers regarding suitable land for crops.

- Sub-district Volunteer Soil Doctors will be trained to be trainers on soil rehabilitation and improvements such as producing compost and liquid organic fertilizer, improvement of soil by green manure, and plantation of vetiver grass.

- The LDD will provide Sub-district Volunteer Soil Doctors with tools for technology transfer such as soil test kit to conduct basic analysis of soils for farmers.

(ii) Establish and develop one learning center for each Sub-district; Establishment of Sub-district learning centers for land development by:

- Implementation of land development demonstration plots suitable for each sub-district for effective technology transfer and exchange of knowledge and experience among farmers so that the land will be effectively used,

- Sub-district Volunteer Soil Doctors will represent the LDD to provide services to farmers at sub-district and village levels.

(iii) Establish one land development service center for each Sub-district

Establish land development service centers in each tambon where Sub-district Volunteer Soil Doctors are located. All Village Volunteer Soil Doctors will function as a network to support farmers in their own villages with soil improvement material and transfer of knowledge. The centers and network will help to extend the opportunity for farmers as a whole to have quick, efficient and extensive access to government services.

Strategy 2: Improvement of organization management to become a learning organization with good governance focusing on preference of customers.

(i) Development of information and information technology systems Increase management effectiveness in various aspects of application of LDD information technology by: updating, correcting, and improving the existing information as well as MIS and GIS technology programmes for more convenience, quickness, and accessibility, and also developing new application programmes.

(ii) Improvement of organizational structure and capacity building for staff

- Improvement of organizational structure to be proactive for field operations
- Changing role from implementer to advisor and facilitator
- Strengthening and capacity building for staff to become a leaming organization ready for operational mechanisms by: development of skill, raising knowledge on scientific and information technology.
- Establishment of mutual development and management networks in order to serve the mission qualitatively and quantitatively

(iii) Development of good governance principles: Continuously implement a transparent strategic plan with internal control of public service output (P.S.O.) and public service agreement (P.S.A) to increase management efficiency, to clearly control and investigate the operation, and to effectively decrease risk and error of management.

Projects and activities

In responding with above programs, the supporting land development projects and activities will be organized as follows:

Land rehabilitation and soil improvement

(i) Soil and water conservation system,
(ii) Development of watershed conservation of Songkla Lake Basin,
(iii) Land development in specific areas
(iv) Tree plantation to protect soil salinization in Khong, Chee, and Moon river basins
(vi) Rehabilitation of abandoned tiger prawn farming areas
(vii) Soil improvement by compost and liquid organic fertilizer
(viii) Soil improvement by green manure
(ix) Saline soil improvement
(x) Acid soil improvement
(xi) Acid-saline soil improvement
(xii) Acid-sulfate soil improvement

(xiii) Vetiver grass plantation
(xiv) His Majesty the King Initiative Projects
(xv) Transferring of technology to farmers

Water resource development

(i) Development of small-scale water resources
(ii) Development of areas under water-use management systems
(iii) Improvement of natural water resources as sources of production base for communities
(iv) Provision and development of farm ponds
(v) Provision and development of ponds to practice New Theory in school

Zonation of suitable soils for cropping

(i) Preparation of land-use zones
(ii) Conducting land-use survey and production estimation
(iii) Conducting soil survey

Strengthening and capacity building of sub-district and village Volunteer Soil Doctors

Implementing demonstration plots and establishing one agriculture learning center for each sub-district.

Provision of soil analysis service

Development of soil Information systems to serve farmers' requirements by:

- developing information systems, and
- developing data base systems for transferring agricultural technology for sub-district centers.

Conducting land development and bio-technology research to increase crop production

Development of agro-tourism

National development policy and climate change

General policy: After ratification of the UNFCCC in 1994, Thailand established a national subcommittee on climate change under the National Environment Board. The sub-committee served as a climate change policy making body and guided Thailand's positions in the climate change negotiation process. Thailand ratified the Kyoto Protocol in 2002. In 2006, the sub-committee on climate change was upgraded to become the National Climate Change Committee chaired by the Prime Minister. Under the National Committee, three sub-committees in charge of the technical, negotiation and public relations aspects of climate change were established.

National Climate Change Committee: NCCC

In Thailand, the Office of Natural Resources and Environmental Policy and Planning (ONEP), under the Ministry of Natural Resources and Environment (MONRE), is the national main focal point to the UNFCCC. Historically, the National Climate Change Sub-committee was established under the National Environmental Board after the country ratified the

UNFCCC. In July 2007, the government upgraded the National Climate Change Sub-committee to the National Climate Change Committee (NCCC), chaired by the Prime Minister. As shown in Fig 4, the committees consist of the permanent secretaries from nine economic ministries and national economic authority (the National Economic and Social Development Board: NESDB) with up to nine committees from experts in related fields while the permanent secretary of MONRE also acts as a committee and committee's secretary. Technical subcommittees are also established under the national committee to support different aspects of climate change issues, including mitigation and vulnerability and adaptation. Thailand has the strategic plan on climate change and is currently developing its ten-year action plan

1.Strategic and action plan on climate change National Strategic Plan on Climate Change Management (2008-2012) Approved by the cabinet on 22 January 2008 (Office of Natural Resources and Environmental Policy and Planning, 2008), the Ministry of Natural Resources and Environment has launched the strategic responses to climate change covering the year 2008 to 2012 The strategies and corresponding action plans are summarized as follows:.

1) Building capacity to adapt and reduce Thailand's vulnerability to climate change impacts. This strategy aims to protect and conserve natural resources as well as to improve adaptability in the natural resource, agricultural, and industrial sectors. The corresponding action plans include, 1) creating capability to assess climate change impacts, 2) preventing and mitigating damage caused by climate change impacts, and 3) creating adaptation capacity in all sectors such as natural resources, agricultural and industry.

2) Promoting greenhouse gas mitigation activities based on sustainable development: The goal of this strategy is to promote clean technology in the various sectors. Mitigation activities could include, for instance, increasing energy efficiency, promoting the use of renewable energy, minimizing solid waste and chemical use in farms, recycling material, as well as increasing carbon sinks by forest conservation.

3) Supporting R&D to better understand climate change and its impacts as well as adaption and mitigation options: This strategy aims to provide useful information to policy makers via technical and academic support from climate change researchers. It involves supporting R&D and climate change knowledge management Through this strategy, the action plans could involve 1) generating and providing knowledge on climate change, 2) developing database on climate change impacts and adaptation options in all relevant sectors, 3) creating knowledge management on GHG mitigation options, and 4) developing appropriate mechanisms to inform policy makers.

4) Raising awareness and promoting public participation: The objective of this approach is to motivate public awareness and to promote common understanding on the roles of the local community on climate change issues. The corresponding action plans are 1) organizing public awareness campaigns and outreach activities on a regular basis 2) promoting awareness in the educational sector, and 3) developing mechanisms to evaluate the effectiveness of campaigns and outreach activities on a regular basis.

5) Building the capacity of relevant personnel and organizations to establish a framework for knowledge and technology coordination and integration: This strategy aims to promote collaboration between personnel and organizations involved in climate change to transfer and share knowledge, technology, and experience. The corresponding action plans include 1) supporting continuous training and skill development related to climate change and 2) creating mechanisms for knowledge and technology transfer in the organization and across the organizations.

6) Supporting international cooperation to accomplish the common goal of climate change mitigation and sustainable development: This approach promotes international cooperation to transfer and share knowledge, technology, and experience. The action plans include 1) integrating climate change implementation under relevant international

frameworks and 2) promoting skill development and knowledge and technology transfer among relevant organizations dealing with climate change in the international level.

National Master Plan on Climate Change 2010-2019

To enable the implementation of the National Strategy for Climate Change, ONEP transformed these strategies into the "National Master Plan on Climate Change 2010-2019." The ten-year master plan consists of three approaches:

Strategy 1: Creating adaptability to respond and reduce the impacts of climate change.

Strategy 2: Supporting GHG reduction and increasing carbon sinks under sustainable development schemes.

Strategy 3: Integrating knowledge, databases, and tools on climate change management.

Key Policies and Plans to Promote Green Growth

The 11th National Economic and Social Development Plan (2012 – 2016): Thailand's National Economic and Social Development Board formulates development strategies at the national and other levels. The current plan includes a Green Policy that calls for addressing climate change more rigorously and moving toward a low-carbon economy and society.Thailand Climate Change Master Plan
(2012–2050): The Climate Change Master Plan is a framework of integrated policies and action plans relating to climate change. It supports climate change preparedness
initiatives and aligns with the country's economic andsocio-cultural contexts, and sufficiency economy philosophy. The plan includes three key strategies:

1. Mitigation of greenhouse gas (GHG) emissions and increase of GHG sinks to promote sustainable development

2. Strengthening the capacity of human resources and institutions and to manage the risks from the effects of climate change and cross cutting issues

3.Adaptation for coping with the negative effects of climate change

Sectoral Initiatives

Energy

- Targeting a 25 percent GHG energy intensity reduction by 2030, with alternative energy comprising 20 percent

of total energy use

- Developing the 20-Year Energy Efficiency Development and the Alternative Energy Development Plan

Agriculture and Forestry

- Encouraging local authorities to enhance carbon sinks throug forestation and sustainable forest resource management
- Allocating national budget to establish an information center and satellite systems to track forest cover, land use, and land-use change

Waste

- Developing an incentive scheme to promote electricity generation from waste, including plans to build a plant in Bangkok

Sub-national

- Promoting the "Clean City Clean Mind" and "Low Carbon City" initiatives, providing technical assistance to local governments

VI. Conclusion/recommendations

Since 1961, Thailand's five-year national economic and social development plans have provided a framework for sustainable development. Over the past four decades, Thailand has gradually improved the process of sustainable development. Development priorities as well as the planning process and implementation have been adjusted to national, regional circumstances and global development dynamics. At present, Thailand is implementing the 10th Plan (2007-2011) and is preparing the 11th Plan (2012-2016). Due to increasing deterioration of natural resources and the environment, Thailand has promulgated the Enhancement and Promotion of the National Environmental Quality Act (B.E. 2535). Under the Act, a five-year action plan for environmental quality management is prepared on a regular basis. At present, Thailand is implementing the Environmental Quality Management Plan for 2007- 2011. It is noted that the planning periods for economic and social development and environmental management are in parallel. This is to ensure the country's economic cum environmental development process. The committees working on the Plans are composed of stakeholders. The planning processes for the two Plans are similar. A bottom-up approach through stakeholder consultation is used. The planning process is coordinated and integrated to ensure full consideration of natural resource and environmental conservation in the economic and social development path, leading to the country's sustainable development. In conclusion, Thailand's economic and social development planning is consistent with the sustainable development concept. Through a process of parallel planning, natural resource conservation and environmental protection are integrated into the economic and social development of the country.

VII. References

1. Land Development Department 2012, The Master Plan and Strategies for Land Development Programmes in 2012-2016 Ministry of Agriculture and Cooperatives Bangkok Thailand.
2. National Economic and Social Development Board 2011, The Eleventh National Economic and Social Development Plan, B.E. 2555 – 2559 (A.D. 2012 – 2016) 2011, Office of the Prime Minister Bangkok, Thailand 186p
3.Office of Natural Resources and Environmental Policy and Planning 2011Thailand's Second National Communication Under the United Nations Framework Convention on Climate, Ministry of Natural Resources and Environment Bangkok, Thailand 102 p.
4. National Science Technology and Innovation Policy Office (STI) 2012Technology Needs Assessments and Technology Action Plans Report for Climate Change Mitigation/Adaptation in Thailand Ministry of Science and Technology, Bangkok Thailand 175 p.
5.Land Development Department National Action Programme for Combating Desertification, 2004 Ministry of Agriculture and Cooperatives, Thailand 35p.

Vietnam -1

Managing Vietnamese soils to respond to climate change. Improve soil carbon stock and GHG mitigation in rice production

Pham Quang Ha
Institute for Agricultural Environment (IAE/VAAS), Phu Do, Tu Liem, Hanoi, Vietnam
Correspondence author: haphamquang@fpt.vn; pgha-nisf@hn.vnn.vn

Abstract: According to FAO-UNESCO classification, Vietnamese soils are classified in 14 main great soils groups with 31 units. Among of 33,115,000 ha of total Vietnamese soils in main land, only less than 10 million of ha are used for agriculture. This paper reported the results of organic carbon study in term of total concentration of more than 1200 soils samples collected in 6 main great groups of Vietnamese soils: Fluvisols; Acrisols (degraded soils); Ferralsols; Arenosols (sandy soils); Acid sulfate soils; Saline soils. These are main soils located for agricultures activities. Carbon stock in soils was interpreted as organic carbon content analyzed in upper layer with the Walkley-Black methods. The results showed that, Acid sulfate soils had highest organic carbon content with the mean of 3.80 %; ferrasols had an organic carbon content of 2.22 (%) in the second place followed by fluvisols (1.99 %) and saline soils (1.72%) and acrisol (1.08 %). the organic carbon content in sandy soil (arenosol) was the lowest (0.68%). Organic carbon and therefore carbon stocks in soils were much closed correlated with soil texture and agricultural practices. General tendencies of carbon stock in Vietnamese soils are slowly decreasing in annual cropping systems, especially in cash crop and vegetable farming. Farm yard manure and crops residues returning to soils may significantly contribute to improvement of soil organic level in soils. Improving carbon stock in some great soil groups was discussed to guide cropping and inform the acceptable carbon level in soil. Agriculture plays a very important role in Vietnam economy with more than 70% engaged population and 20-24% in GDP. Signs of climate change affected agriculture production and farmer's income have been identified not only by scientists but by both local authorities and farmers. Rice production in Vietnam, over last 50 years (1960-2010), was increased in both crop yield (2.51 times), cultivated area (1.53 times) and therefore rice production was increased by 3.84 times. Vietnam produced today more than 35.53 million ton of rice per year in total of 43.2 million ton of grain food. This provided enough food more than 85.6 million Vietnamese and contributed to world food security. Vietnam is now the second world rice exporter with a total about 4-5 million tons of rice annually. As rice production areas in Vietnam are located mainly in Mekong River Delta (MRD) (51%) and Red River Delta (15%), these zones are considered the most affected by climate changes, in which, high sea level rises have been forecasted. With the worse cases, in 2100, more than 1.1 million ha of rice land in MRD will be deeply submerged and some thousands hectares of rice land in RRD will be salted. In addition, extreme climate such as heavy storms, irregular rainfalls distribution; droughts, unpredicted disease epidemics are big challenges for Vietnam to keep a stable rice production in the end of this century. Different measures and actions were considered and taken in Vietnam. Both adaptation and mitigation options were mentioned. It is hopefully that Vietnam can take over the new challenges in the coming decades to reach successfully the target of 3.8 millions ha of soils for rice with a production annually of 43 millions ton of rice as formulated by the year 2020. Promising solution should be taken is to reduce the amount of chemical conventional fertilizers application (10-15%) and to use environment friendly nutrients from organic and inorganic sources, to develop and use new type and new technique of fertilization such as

bio-char, wet and dry alternative irrigation in rice production integrated with minimum tillage and mix cropping systems

Keywords: organic carbon; Vietnam soils; carbon stock; climate *change, rice production, GHG, mitigation, Vietnam*

1. Introduction

Vietnam counts today more than 85.7 millions of people and Vietnam's inland surface is 33,115,000 ha. Most of Vietnamese lands are under forestry (44.7%), only 28.4 % are used for agriculture with the total surface of 9,420,300 ha (Table 1). Faced with high population pressure (85,6 millions people), food security has becoming overriding political and economic goal in the past twenty years and in the day coming with the challenge of the climate changes.

Table 1. Land use in Vietnam

Areas as classified by land used (2008)	Area (ha)	%
Agriculture land	9,420,300	28.4
Forestry land	14,816,600	44.7
Non-Agricultural land	3,385,800	10.2
Aquaculture land	728,600	2.2
others lands	3,666,300	11.1
Water surface	1,097,400	3.3
Total of Vietnam Areas	33,115,000	100

Vietsat (2008)

Rice, maize, cassava, peanut, soybean, sweet potato are the main food crops while rice remains the dominated crop in area and in production of Vietnam with the total annual planted areas more than 8,3 million ha and a production of 35,9 millions tons (data 2007, Table 2). It is noted that only less than 4,000,000 ha of land are allocated for rice planting, but farmers have two or even three rice seasons annually.

A recent overview of rice production in Vietnam (Pham Quang Ha, 2010) reported that, over last 50 years (1960-2010), rice production in Vietnam was increased both yield (2.51 times), area (1.53 times) and therefore rice production was increased up 3.84 times. Vietnam produced 35,942,700 ton of rice in 2007 and 38,725,100 million ton in 2008. This provided enough food more than 85.6 million Vietnamese and contributed to world food security. Vietnam is now the second world rice exporter with a total about 4-5 million tons of rice annually.

Rubber, coffee, cashew nut as well as tea and pepper are also promising cash crops for Vietnam. The areas planted for rubber and coffee were 536,300 and 509,300 ha, respectively, in 2007.

As rice production areas in Vietnam are located mainly in Mekong River (51%) and Red river delta (15%), these zones are considered most affected by climate changes where high

sea level rises expected in different scenarios. With the worse cases, in 2100, more than 1.1 million ha of rice land in Mekong delta will be deeply submerged and some thousands hundreds of rice land in Red river delta will be salted. In addition with irregular storm, rain fall distribution, drought, plant deceases; it is a big challenge for Vietnam to keep a stable rice production in the end of this century. Different measures and actions were considered and taken by Vietnamese government and the Ministry of Agriculture and Rural development. Both adaptation and mitigation options were mentioned. It is hopefully that Vietnam can take over the new challenges in the coming decades to reach successfully the target of 3.8 million ha of soils for rice with a production annually of 43 million ton of rice as formulated by the year 2020.

Table 2. Main crops production in Vietnam

		1000 ha	1000 tons	
N.	Crops	Planted area	Production	Crop classification
1	Rice	8,304,700	35,942,700	Food
2	Maize	1,096,100	4,303,200	Food
3	Cassava	495,500	9,395,800	Food &cash
4	Peanut	254,500	510,000	Food & cash
5	Soybean	187,400	275,200	Food & cash
6	Sweet potato	175,500	1,437,600	cash
1	Rubber	556,300	605,800	Industrial
2	Coffee	509,300	915,800.00	Industrial
3	Cashew nut	439,900	312,400	Industrial
4	Sugar Cane	293,400	17,396,700	Industrial
5	Coconut	135,300	1,034,900	Industrial
6	Tea	126,200	705,900	Industrial
7	Pepper	48,400	89,300	Industrial

(Vietsat, 2008)

2. The Distribution of Major Soil Groups and Soil characteristics

According to FAO-UNESCO classification, Vietnamese soils are classified in 14 main great soils groups with 31 units. Main great soil groups used for agricultural activities are shown in the table 3; and its distribution along the country is showed in the table 4. Selective characteristics of these soils are showed in the table 5. It is noted that, these soils are mainly acidic as found in most tropical soils.

Table 3. Soils in Vietnam selon Fao-Unesco or local classification

No	Main soil types/ local name	FAO- Unseco	Area (ha)	%
1	Sandy soil	Arenosols	533,434	1.6
2	Saline soil	Salic fluvisols	971,356	2.9
3	Acid sulfate soil	Thionic Fluvisols	1,863,128	5.6
4	Alluvial soil	Fluvisols	3,400,058	10.3
5	Red Soil	Ferralsols	3,010,594	9.1
6	Grey Degraded soil	Haplic Acrisol	1,791,021	5.4
7	Ferralitic Soils	Other Acrisol	18,179,621	54.9
8	Other lands/areas	Other	3,365,788	10.2
Total of Vietnam Areas			33,115,000	100

Vietnam soil (1996)

Table. 4. Soil in Vietnam, distribution and dominant crops.

No	Main soil types	Main distribution areas	Dominant crops types	Annual harvesting seasons
1	Sandy soil	Coast central	Rice, peanut & cash crops	> 2
2	Saline soil	Coastal north and south	Rice, cassava & cash crops	1-2
3	Acid sulfate soil	Red & Mekong Rivers Deltas	Rice, cassava & cash crops	1-2
4	Alluvial soil	Mekong (MKRF) and Red Rivers (RRF) and others (ORF)	Rice, maize & cash crops	>2
5	Red Soil	Central high plateau; North hills & mountains	Maize, coffee, rubber & other industrial crops	1-2
6	Grey Degraded soil	Midlands of north & southeast	Rice, maize, & cash crops	>2
7	Ferralitic Soils	Hills & mountainous areas	Forestry & cash crops	1-2

Table 5. Selected characteristics of main soil types/groups for agricultural purposes

No	Main soil types	pH_{KCl}	N%	Clay (%)	Bulk density (g/cm^3)
1	Sandy soil	4.76-5.74	0.05-0.06	2.9-6.2	1.20-1.67
2	Saline soil	5.05-5.35	0.15-0.16	38-58	0.92-1.38
3	Acid sulfate soil	3.54-3.79	0.22-0.25	42-57	0.79-0.99
4	Alluvial soil	4.51-4.67	0.17-0.19	33-41	0.82-0.97
5	Red Soil	3.99-4.10	0.17-0.18	49-55	1.02-1.09
6	Grey Degraded soil	4.26-4.41	0.09-0.11	11-18	1.32-1.35

3. Rice production in Vietnam as affected by climate change

Climate change

Human's socio-economic activities with high level of fossil energy consumption caused more and more green house gas (GHG) emission into the atmosphere. This induced the climate change. With the main manifestation of global warming and sea level rise. The most impact of climate change for Earth consists of four phenomena: global temperature increases up; sea level rises; natural disasters occur frequently and more intense; some form of natural resources and biodiversity loss or change in the not wanted direction.

Global warming and climate system change (CC) are going together. According to the Stern

report, CC is a global and long term problem; it contains many unstable uncertainties; CC is likely to affect a very large scale and almost irreversible. These changes will create more unpredictable impact in the future. It is a real disadvantage that humankind faces. The impacts of climate change have shown quite clearly in recent times.

The unusual heat waves and drought in Europe, Africa; floods in Asia, in the Americas are terribly becoming increasingly unpredictable and terrible destroyable. Recent floods in Pakistan, France, China destroyed millions houses, killed thousands peoples. Heat waves recently in Moscow up to 40 degrees Celsius (8/2010) firing thousands hectares of forest, houses, villages have forced the Russian president to declare the state of emergency across to the six provinces. Such phenomena showed evidence of instabilities and uncertainties. The biggest threat is the long-term climate change leads to unusual climate and severe weather, direct impacts to agricultural production and people's lives, especially to poor people, to poor regions. Droughts, floods, water logging, salinization will occur more often. Severity levels also are reflected in the extremely ability to hot, to cold no unpredictable and happening irregularly.

According to the fourth assessment report of IPCC in 2007, the average global temperature has risen about 0.74 °C during the period 1906 to 2005 and the rate of temperature increase in 50 years, nearly double the 50 year earlier. The temperature on the continent increased faster than in the Ocean. In 100 years, rainfall tended to increase at high latitude regions. The high intensity rainfall tended to increase in many regions of the world. Global sea level during the period 1963-2003 increased 1.8 mm/year, and in the period 1993-2003 was 3.7 mm/year (IPCC, 2007).

Scenario temperature increase and sea level rise in Vietnam

Scenario for temperature increasing and sea level rising in Vietnam in 21 centuries has been developed and released in June 2009 (MONRE, 2009) based on high emissions scenario (A2), medium (B2) and low (B1). Results showed that by 2100, annual average temperature in different agro-ecological zones of Vietnam can increase up an average of 1.1 to 1.9 ^{0}C for B1 scenario; from 1.6 to 2.8 ^{0}C for B2 scenario and from 2.1 to 3.6 0C for the A2 scenario.

Table 6. Vietnam temperature increased scenarios (^{0}C) compared with the period 1980-1999

Emissions scenarios	The increase in temperature	2020	2050	2100
B1	High increase ^{0}C	0.5	1.4	1.9
B1	Low increase ^{0}C	0.3	0.8	1.1
B2	High increase ^{0}C	0.5	1.5	2.8
B2	Low increase ^{0}C	0.3	0.8	1.6
A2	High increase ^{0}C	0.5	1.5	3.6
A2	Low increase ^{0}C	0.3	0.8	2.1

According to the World Bank (WB 2010), world efforts and commitments urge to reduce GHG emissions so that by the end of this century, global temperature will increase only below 2^{0}C. This is corresponding to the low-emissions scenario (B1). In such case, average temperature in Vietnam will be increased only from 1.1 to 1.9 ^{0}C.

IPCC (2007) estimated sea level rise of about 26-59 cm by 2100. Some scientists believe that the calculation of the IPCC on sea levels is slightly lower because not fully account the level of ice melts.

Sea level rise scenarios for Vietnam in low, medium and high emission hypothesis are computed in table 7. Results showed that in 2050 sea level will be higher than today level from 28 to 33 cm and at sea in 2100 would be higher from 65 to 100 cm.

Table 7. Vietnam sea level rise (cm) scenarios compared with the period 1980-1999

Emissions scenarios	Emissions	2020	2050	2100
B1	Low	11	28	65
B2	Medium	12	30	75
A2	High	12	33	100

Lost of rice land, a real potential damage to rice production

Damage production by loss of rice land based on scenarios of climate change for Vietnam is very serious (MARD. 2009). Most of the potential flooded area (Red River Delta and Mekong River Delta) is the rice bowl of Vietnam's contemporary.

By the 2100, at 1 meter sea level rise scenarios, most of the provinces in Cuu Long River Delta Region (MRD) will be submerged in water or serious saline water intrusion (Figure 1. MONRE. 2008).
Computed results in the table 3 showed lost of rice production in 10 provinces in Mekong Delta and Ho Chi Minh (TP. HCM) hypothesized as the most affected areas, where 38.29% of land will be submerged under sea water among that 31.16% are agricultural land and it is mainly allocated for rice production.

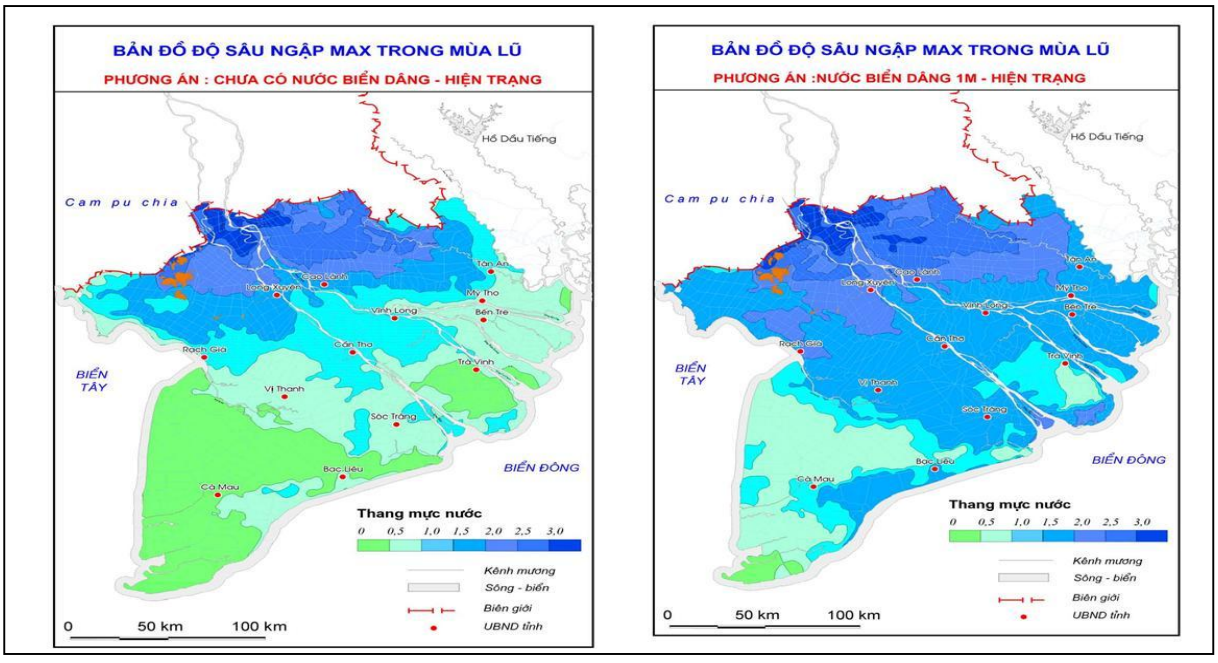


Figure 1. Current flood maps (left) and at 1 meter sea level rise scenario (right) in the MRD Region during the flood season. (MONRE. 2009; MARD. 2008).

Table 8. Forecast rice production as affected by1m sea level rise in 10 Southern provinces

Province	Area of natural land (1000 hectares)	Natural land flooded (1000 hectares)	Estimates of land owned submerged (1000 hectares)	Yields average (Tons / ha / crop)	Number of cases per year	Yield loss (1000 tons)	Value is lost (1000 billion) *
Bến tre	231.5	113.1	81.7	4.06	2.0	663.7	2,522.0
Long An	449.2	216.9	160.0	4.08	2.0	1,305.3	4,960.3
Trà Vinh	222.6	102.1	83.5	4.43	2.0	739.9	2,811.7
Sóc Trăng	322.3	142.5	116.6	4.93	2.0	1,150.1	4,370.2
TP. HCM	209.5	86.2	39.2	3.17	2.0	248.6	944.6
Vĩnh Long	147.5	60.6	49.2	4.77	2.0	468.9	1,782.0
Bạc Liêu	252.1	96.2	80.4	4.66	2.0	749.0	2,846.3
Tiền Giang	236.7	78.3	60.1	4.90	2.0	588.5	2,236.3
Kiên Giang	626.9	175.7	112.8	4.61	2.0	1,040.5	3,953.7
Cần Thơ	298.6	75.8	64.6	5.18	2.0	669.6	2,544.5
Total	**2,996.8**	**1,147.4**	**848.1**	**44.79**	**2.0**	**7,597.4**	**28,870.2**
Structure (%)	-	38.29	32.16	-	-	40.52	40.52

*IAE. 2010. * value 2008 year.*

3. Carbon stock in soils as affected by soils types and soil characteristics

The term soil organic carbon (OC) has been used to measure indirectly the soil organic matter. Soils organic matters are not the same as biomasses in soils. As we define soils with three components: solids; gas and liquid. It is not easy to distingue soil organic carbon and soil biomasses.

The results of organic carbon study in term of total concentration of more than 1271 soils samples collected in 6 main great groups of Vietnamese soils used for agricultures activities: Fluvisols; Acrisols (degraded soils); Ferralsols; Arenosols (sandy soils); Acid sulfate soils; Saline soils. Both acid sulfate soils and saline soils are bearing alluvial and marine features, but acid sulfate soils are often newly explored and long year ago organic deposit in sea side explaining the highest carbon content in acid sulfate soils. The lowest clay content in sandy soils explains why in this soil, organic carbon is the lowest. Among other soil characteristics, computed for all fluvisols together, only soil nitrogen content was very high significantly correlated with organic content in soils. Table 9 showed linear regression coefficients between selected soils characteristics and organic contents in fluvisols.

Linear regression was made for the great group of alluvisol (fluvisols) in the Table 10, only nitrogen content was very high significantly correlated with organic carbon content in soils. In fluvisol, OC in soils is also expected as a fuction of alluvial deposit and land uses. Figure 1 showed nomal distrubution of organic carbon in fluvisols.

Table 9. Organic carbon in main groups of agriculture soils (OC%)

STT	Parameters	Alluvial soil	Red soil	Grey degraded soil	Sandy soils	Saline soil	Acid sulfate soils
1	N. of samples (n)	211	233	229	212	230	156
2	Mean, OC %	1.99	2.22	1.08	0.68	1.72	3.8
3	Min, OC %	0.31	0.60	0.078	0.116	0.293	0.515
4	Max, OC %	4.04	4.14	3.22	1.698	3.694	7.294
5	Standard deviation	0.80	0.7	0.62	0.368	0.638	1.56

Table 10. Linear regression considering organic content is soils as dependent variable.

Predictor variable	Coefficient	Standard error	P (accepted)
Constant	1.18	0.40	0.004
CEC	0.01	0.01	0.381
K	-0.12	0.09	0.216
N	10.4	0.76	0.000
P	0.55	1.31	0.675
pH_{H2O}	-0.004	0.167	0.997
pH_{KCl}	-0.207	-1.28	0.201

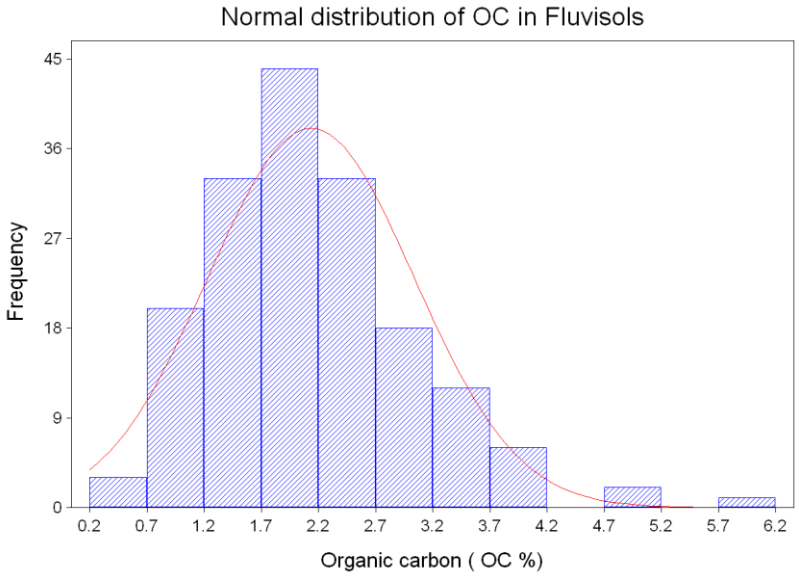


Figure 2. Distribution of organic carbon in Vietnam fluvisol.

4. Carbon stock in soils as affected by cropping systems

Carbon stocks in soils were highly affected by cropping systems. Among 172 samples computed for fluvisols, there are 7 combinations of cropping systems entitled in the Table 11 and Figure 3. Results showed that, on the rice (R) based cropping systems organic carbon

contents were the greatest. Lower carbon contents were found in cash (C) based cropping systems.

Table 11. Organic carbon in soils in different cropping systems in fluvisol

Plant growth	Cropping systems	OC%	STD
Mulberry (cash crop)	C	0.93	-
Non rice annual crops such as vegetable, maize, leguminous (Cash crops)	C-C	0.76	0.01
Three cash crops	C-C-C	1.28	0.47
1 Rice-1 cash crops	R-C	1.49	0.05
Two rice crops	R-R	2.09	0.77
Two rice + 1 cash crops	R-R-C	1.40	0.56
Three rice crops	R-R-R	2.13	0.77

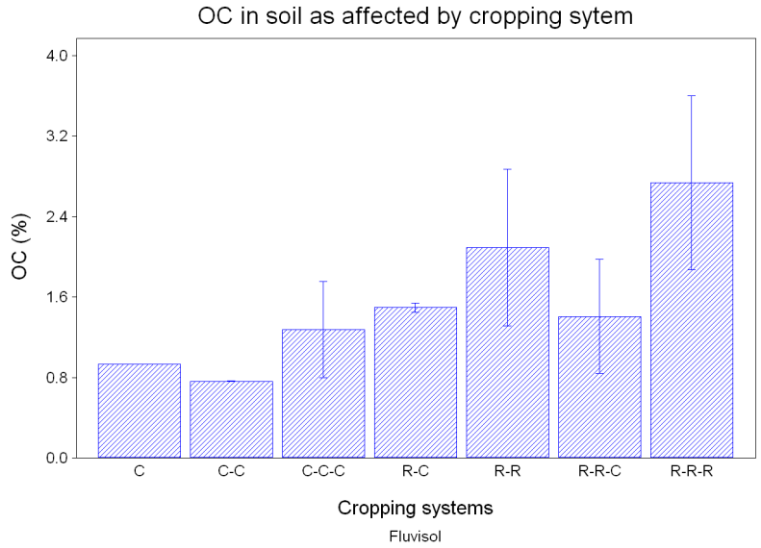


Figure 3. Organic carbon in Fluvisol as affected by cropping systems

It is critical to understand the difference in decomposition patterns of organic input and the role of organic matter in different cropping systems. The process is totally different between upland soil and under water soils. For example, in rice only cropping systems (2 or three rice cropping yearly) with short aerobic fallow periods, anaerobic decomposition leads to the development of more stable organic component, for that more organic carbon in soil remain stable and well conserved. In the other hand, soil for rice only is often under low land, submerged; the clay content are found higher in the upland soils. In heavy clay content soils, total soil organic content is increasing with time and reaching a new equilibrium

5. Improvement soil productivity an integrate solution to carbon stock in sandy soils

More then 36% of agricultural soils are classified as light textured degraded soils (such as arenosol and acrisol) that have a low inherent nutrient supplying capacity, low organic matter content and limited water holding capacity. Among these soils, about half of million hectares are sandy soil mainly located in coastal areas. Sandy soil occupied only 1.61 % of the territory and 4.61 % of agricultural soil but where leaving more than 10 millions peoples (14 % Vietnam population). Often in these areas, farmers are poor and high venerable.

In Vietnam, sandy soil are distributed mainly in central coastal provinces including Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, Thua Thien-Hue, Ninh Thuan, Binh Thuan and along some big river sides where soil developed in situ derived from sandstone and granite rocks. According to Vietnam soil association (1996), the Vietnamese group of sandy soils may be classified mainly into 3 units: white and yellow sand dune soils; red sand dune soils and sandy marine soils. In this case study, we report the results collected from different studies on sandy and light textured soil management in Vietnam including a cooperation project with Belgian universities focused on coastal sandy soils of Central Vietnam and a North Vietnam sandy soils monitoring project.

5.1 Vietnam Sandy Soil fertility status

Beside two alluvial soils of Vietnam (Red river fluvial soil and Mekong river fluvial soil), soil fertility in Vietnam is not very high. The widespread soils in Vietnam have low pH, low C, low N and very low CEC. It is especially true for soil with light texture as sandy soil or acrisol. The dominant feature of the central coastal sandy soil (Haplic Arenosol) was shown in the Table 12. Results of routine soil testing conducted recently reveal that, most of Vietnamese sandy soils had low organic matter content. All of studied soil samples are deficient in N, P, Ca and 50% in Mg.

In farming, the strategies of farmers are different from scientists. The dominant criteria to scaling up the scientific finding is increasing the soil productivity and therefore increasing income for farmers. The approach to improve the carbon stock in soils should be an integrate approach where the interest of the farmers in short and medium term should be firstly considered.

5.2 Soil acidity and organic content in soil as key limiting factors

Light texture is considered as key factor limiting soil productivity but it is not easy to increase clay content of sandy soil. Acidity and organic content are usually cited as two main critical chemical characteristics when managing sandy soils. Acidity of sandy soils depends on type sandy soil formation and profile. Generally, sandy soils are acidic with the pH_{KCl} below 5 but in particular cases, pH_{KCl} of Vietnam sandy soil may reach more than 6.0 units. For the organic carbon content, analysing 300 cultivated sandy soil samples from Thua Thien Hue province, results showed a very large variation of organic content. The average was 1.08 with the standard deviation of 0.67. Both acidity and organic content of sandy soil may be influenced by agronomy activity, water logging condition, rate of organic material mineralization and sea water intrusion. Figures 4 showed pH and organic content (OC) distribution of sandy soils in Thua Thien Hue province.

5.3 Management of sandy soil in Vietnam is usually sequenced in different steps.

5.3.1 Land use planning

Land use planning is probably the first important step in managing sandy coastal areas and sandy soil. Topography of sandy coastal soil may be distinguished by flat forms or moving dunes; flat sandy with coarse grain layers are managed to foods and different foodstuff crops; while moving dune sandy with fine grain is most difficult to manage. Normally, government takes firstly action. Land use planning should be realized at different scales, both at regional and farm level. Land management at regional or provincial level may follow

national program approach such as afforestration program, national action plan for anti-desertification or eradication of poverty campaign. At farm level, farmer should adapt and analyze what may fit the family's requirement in food and in cash and it depends on their capital and labor capability. It depends also on local weather condition and the variation of the market. Farmers' decision is very much influenced by their need in food. At the country level, Vietnam is at safe food security but it is not true for every household in coastal areas. It is suggested that in such case land use planning should go through participatory way that involves both the need and the capability to make action both by authority and inhabitants. Study reported by Nguyen Thuc Thi (2003) showed an example of sandy soil use planning projection by 2010 for three provinces in central coast where dominated sandy soils (Table 13).

Table 12. Selected physico-chemistry of representative Vietnam sandy soil

No	Item	Unit	Mean	Std	n
1	pHH2O		4.61	0.48	75
2	pHKCl		4.10	0.47	75
5	Bulk density	gram/cm^3	1.51		24
6	Density	gram/cm^3	2.65		24
7	Porosity	%	43.0		24
8	Texture				
	2-0.2mm	%	66.60	18.15	75
	0.2-0.02mm	%	19.85	10.26	75
	0.02-0.002mm	%	7.08	6.35	75
	<2mm	%	5.59	5.36	75
10	OC	%	1.08	0.67	300
11	CEC	cmolc/kg	4.52	3.79	75
12	Ca^{++}	cmolc/kg	0.69	0.74	75
13	Mg^{++}	cmolc/kg	0.25	0.36	75
14	K^{+}	cmolc/kg	0.03	0.16	300
15	Na^{+}	cmolc/kg	0.28	0.79	75
16	Al^{3+}	cmolc/kg	0.59	0.67	75
17	H^{+}	cmolc/kg	0.06	0.09	75
19	N	%	0.06	0.03	300
20	P	%	0.02	0.01	300
21	K	%	0.18	0.24	75
22	P (bray II)	mgP/kg	28.8	21.9	75

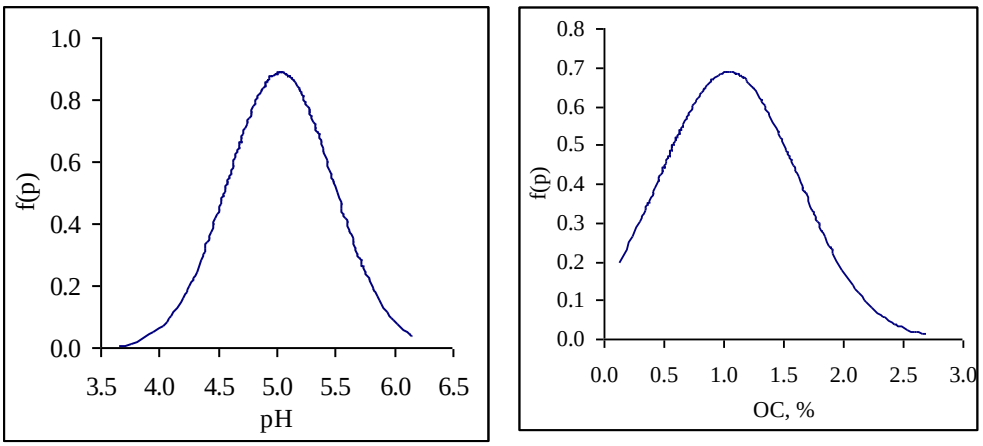


Figure 4. Density function of OC (right) and pH (left) of sandy soil as indicated by Normal distribution

Table 13. Sandy soil use planning projection in 2010 for three provinces (Quang Binh (QB), Quang Tri (QT), Thua Thien Hue(TTH)).

Land use type	Total (ha)	%	QB (ha)	QT (ha)	TTH (ha)
Rice-Rice	11,150	9.4	3,000	1,750	6,400
2Rice + 1cash crop	1,000	0.8	200	500	300
1Rice + 2cash crops	1,900	1.6	1000	700	200
Rice + cash crop	1,250	1.1	700	400	150
Cash crop only	6,000	5.1	1000	2500	2500
Perennial/ fruit tree	250	0.2	150	50	50
Fishery_ Shrimps	550	0.5	100	100	350
Forestry					
Eucalyptus, Casunarinas	72,104	60.8	25,512	21,782	24,810
Total	118,504	100	37,162	34,582	46,760

Source: Nguyen Thuc Thi, 2003

5.3.2 Field engineering and management

About 27% of sandy areas are not still used (Vu Nang Zung et al., 2005). There are several reasons, but one of them is the area is not yet managed. It is clearly agreed that, water field engineering including canal irrigation and drain system, making ridges, reforest tree for fixing moving sandy soil are most important key works. Management in sandy soil should be involved both water management together with forestry and agriculture management (Phan Lieu, 1981).

5.3.3 Choice of suitable crops and cropping systems

Choice of suitable crops and cropping sequence are often very delicate. Casunarina (*Casuarina equisetifolia*), Eucalyptus (*Eucalyptus sp*), Photina (*Phitinia prunifolia*), Kapok tree (*Alba pentandra*), Guava (*Psidium guajava/ Myrtacea*), Jack fruit (*Artocarpus heterophyllus*); Vetiver (*Vestiveria sp*) are frequently cited as plant species that can firstly grown on sandy and using as fixing tree for wooden, fuel, fruit or medicinal purposes.

Cashew (*Anacardium occidentaleL/ Anacardiacea*); Mango (*Mangifera indica L*), Coconut (*Cocos nucifera L)*, Dragon Fruit Tree (*Hylocereus undatus*), Citrus/ Citron Orange (*Cistrus reticulata Blanto*) are also adapted and grown in some coastal area. These trees were very well developed on sandy soils with a good cultural practice such as fertilization for cashew, lighting regulation for dragon fruits.

Table 14. Cropping system in Vietnam sandy soil by 2004

Crops	Percentage
Rice- Rice	7.8
1 Rice	0.9
1 Rice- 1 cash crop	8.2
Cash crop only	13.5
Fruit and perennial tree	5.0
Fishery	0.14
Forestry	27.1

Others	10.5
Total used	72.5
Non used	27.5

Source : Vu Nang Zung et al. 2005.

Permanent dry sandy soils may be used for cash crops such as peanut, maize, sesame while seasonal or permanent flooding areas are very well for rice crops. Tables 14 and 15 showed different land use types in Vietnam sandy soil, yield and its economical values. Fishery seems as most interesting for maximization economical return but this type of land use counts only 0.14%. Forestry is at the lowest economical value land use type and it counts 27.1%. Rice based cropping dominates still all types of sandy land uses.

Table 15. Detail of crop yield and cash value equivalent

Crop/items	Yield range (ton/ha/year)	Cash value in Vietnam 10^6\$/ ha/year
Spring rice(1)	4-6	8 - 12
Summer Rice(1)	3-5	6 - 10
Peanut(1)	1.2-1.8	0.96 – 1.4
Soybean(2)	4.0 – 6.5	3.5 – 5.7
Sesame(1)	0.8-2.3	16 - 46
Maize(1)	2.5-3.5	3.8–5.3
Sweet potato(2)	2.48 – 18.2	2.5 – 18.2
Cassava(2)	4.7 – 22.2	5.6 – 26.6
Dragon fruit(2)	15 -30	90 – 180
Cashew(2)	1.0-1.5	17 – 25.5
Vegetable(1)	30-50	30 - 50
Shrimps(2)	0.9 - 30	9 - 300
Salt field(2)	45000 - 90000	15.8 - 36

Source: (1). Pham Quang Ha, 2005 (un publised data)

(2). Statistical data in Website: http://www.mard.com.vn

6. Multipurpose approaches for increasing soil productivity and carbon stock

Integrated nutrient management is the efficient use of all types and forms of nutrients, both those originating from the field or farm and those from outside the field or farm (Nguyen Van Bo et al. 2003). Balanced fertilization achieved when the cropping system is supplied with the correct proportions of N, P, K, Mg and other nutrients. Further more, in soils can be improved considerably in using crop residues and best practice for land preparation.

There are four main integrating approaches to improve soil productivity and carbon stock in soils:

- Plant crops adapted to indigenous soil nutrient supply
- Improve the soil fertility to meet the crop's requirement
- Fertilization with organic and inorganic materials
- Using crops residues and minimized tillage.

Crop residue management and farm yard manure is a subject to study and to practice in Vietnam especially for light texture soil. Returning crop residues to soil improves significantly

soil physical and chemical properties. However, inappropriate agricultural practices and continuous cropping without adequate nutrient are occurring in many places. The management of sandy soils requires particularly integrated practices that can increase fertility, and the nutrient and water holding capacity. Biological management of the soils can be an effective way to increase soil quality through management of biomass, i.e. farmyard manures, crop residues, green manures, and alley cropping. In addition, the effective management of the soils needs careful consideration of appropriate techniques, not only to address the issue of low productivity, but also to protect the environment such as nitrate leaching, heavy metals accumulation for examples. Synthesis study (Table 16) from National Institute for Soils and Fertilizers (NISF, Hanoi, 1996-2000, un published data) showed clearly crops yields in sandy soils as affected by farm yard manure. Crop yield increased by 158-200% as compared with control treatments. In practice, different types of green or farm yard manures are used (Table 17).

In Thua Thien Hue provinces par examples farmers used buffalo manure, chicken manure, pig manure or plant residues such as rice straws and ash (Table 14).

Table 16. Crop yield (tone /ha) as affected by Farm yard manure (FYM)

Treatment	Sesame	Peanut	Rice	Maize
N P K	0.6 (0.2)	1.2 (0.5)	2.5 (0.3)	1.8 (0.2)
N PK + FYM	1.2 (0.4)	1.9 (0.3)	4.3 (0.6)	3.4 (0.3)
Percentage (%)	200.0	158.3	172.0	188.8

Source: NISF, unpublised data (1996-2000)

Table 17. Carbon and nutritive values of selected materials considered as input for fields (expressed in dry matter)

Types of materials	N. of samples	C %	N %	P%	K%
Buffalo manure	14	11.7	0.64	0.16	0.33
Cattle manure	8	17.8	0.95	0.24	0.62
Pig manure	33	19.2	1.23	0.38	0.54
Chicken manure	6	14.2	1.36	0.60	0.40
Duck manure	5	10.9	10.9	0.24	0.41
Plant residues	22	38.8	1.61	0.17	0.39
Ash	5	3.9	0.25	0.35	1.34

Source: Hoang Thi Thai Hoa (2008)

7. Rice production in Vietnam relative with fertilizer uses and efficiency

Table 18. Food production, Crop yields and fertilizer uses in Vietnam

Year	Food (10^6 T)	Rice Yield (T ha^{-1})	Coeff. Increasing	Maize Yield (T ha^{-1})	Coeff. Increasing	NPK Used (10^3T)
2000	34,5	4,24	1,00	2,74	1,00	2283
2005	39,6	4,88	1,15	3,59	1,31	2071
2010	44,6	5,34	1,26	4,10	1,50	2090

Source: GSO (2010)

Since past 40 years, fertilizers uses in Vietnam were dramatically increased both in inorganic and organic sources. Today, the amount of chemical fertilizers used has excesses 260 units of NPK per ha but its efficiency remains still very low. About 40 to 60 percent of fertilizers unit were loosed. Economically it makes a loss of several hundred of million US dollars annually for national economy and consequently it will disparate in the nature and make the environment become more polluted, more GHG emitted.

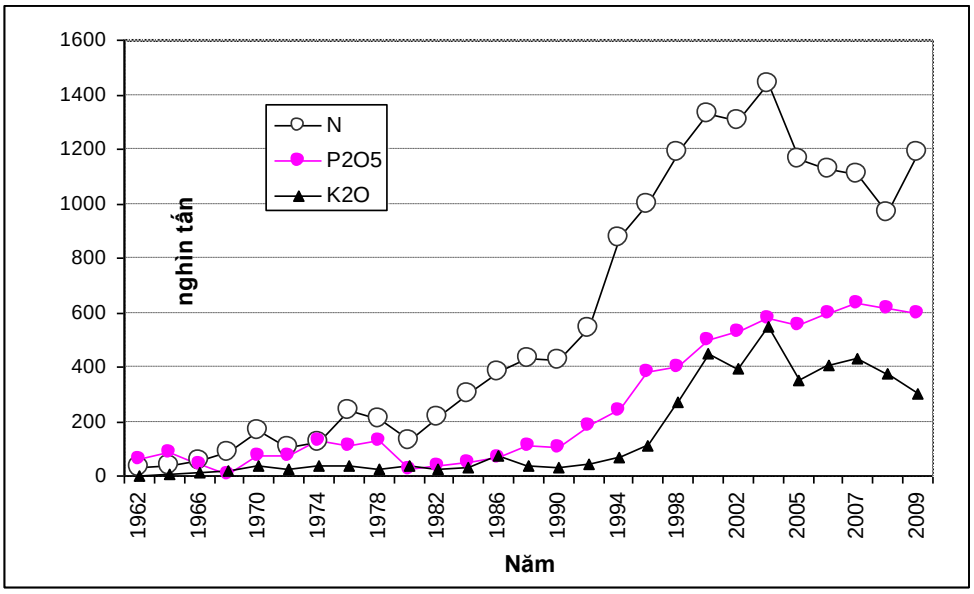


Figure 5. fertilizer uses in Vietnam (FAO, Stat, 2011), 10^3 T NPK

Table 19. Fertilizer uses efficiency in some selective crops

Crop/Soil	Efficiency (%)		
	N	P	K
Spring Rice/Fluvisol	43	21	46
Summer Rice/Fluvisol	36	22	43
Spring Rice/Acrisols	12-50		45
Summer Rice / Acrisols	16-56		
Coffee /Ferrasols		20-36	30
Vegetables /Fluvisols	33-60		20

Sources: Pham Quang Ha and Nguyen Van Bo (2013)

8. GHGs emission from Vietnamese agriculture sectors

GHGs emission from Vietnamese agriculture sectors was estimated for 2000 data great as 43.1% of the total emission from Vietnam (about 65.1 million tones of CO_2e). In which, rice cultivation contributes 57.5%, livestock contribute about 5.3%, enteric fermentation accounts for 11.9% of total GHGs emission from agriculture. Total GHG emissions were also projected for 2010, 2020 and 2030. Emissions from Agriculture sectors will be relatively great as 169.2 M; 300.4 M and 515.8 M tones of CO_2 e. (MONRE, 2010).

Table 20. GHG emission in Vietnam (10^3T)

Sector	CO_2	CH_4	N_2O	CO_2 e	Percent (%)
Energy	45,900.00	308.56	1.27	52,773.46	35.0
Industry	10,005.72	0	0	10,005.72	6.6

Agriculture	0	2,383.75	48.49	65,090.65	43.1
LULUCF	11,860.19	140.33	0.96	15,104.72	10.0
Waste	0	331.48	3.11	7,925.18	5.3
Total	67,765.91	3,164.12	53.83	150,899.73	100

Source: Vietnam Second Communication to UNFCC (MONRE, 2010)

Table 21. GHG emission from Vietnam Agriculture Sectors (10^3T)

Sub-sectors	CH_4	N_2O	CO	NOx	CO_2 e	(%)
Fermentation	382.12				7,730.52	11.9
Fertilizer use	164.16				3,447.36	5.3
Rice Prod.	1,782.37				37,429.77	57.5
Land use		45.87			14,219.70	21.8
Burning Savanna	9.97	1.23	261.71	4.46	590.67	0.9
Agr. Waste	59.13	1.39	1,241.68	50.28	1,672.63	2.6

Source: Vietnam Second Communication to UNFCC (MONRE, 2010)

9. Measurement of methane emission in Rice production

The level of greenhouse gas emissions depend heavily on cultivation mode, the plant watering regimes, and the use of fertilizers. More recent research results show that the alternative irrigation (AWD) not only saves water but also reduces greenhouse gas emissions. Balanced fertilization, using new materials (Bio-char enriched, Fe, etc.) can also increase rice productivity together with reduce greenhouse gas emissions, including CO_2, CH_4 and N_2O.

In our experiments, high peak of CH_4 emission rate appeared at 30 – 60 days after transplanting. It may reach more than 70 mg C/m2/hr for spring rice in fluvisol since 6 weeks after transplanting and 87 mg C/kg/hr in acrisol since 8 weeks after transplanting and than decrease. For Summer rice, figure are different, the maximum absolute rate may reach since 4 weeks after transplanting in fluvisol, but the maximum absolute value was only 27 mg C/m2/hr and the maximum value found in acrisols was 37 C/m2/hr in 6 week after transplanting. CH_4 emission rate from rice soil applied Fe-containing fertilizer trended lower than that from rice soil without Fe-containing fertilizer. Cumulative CH_4 emission rate both two rice seasons from fluvisols and acrisol was decreased by more than 20 % ($p < 0.05$) in comparison with no application of Fe-containing fertilizer.

Table 22. Cumulative CH_4 emission over rice season on Fluvisols and Acrisols in pot in spring 2009 *(mgC/m²/season)*

Treatment	Fluvisols	Acrisols
No application of Fe-fertilizer	20032	23293
Application of Fe-fertilizer	15733	18050
GHG decreasing (%)	21.5	22.5

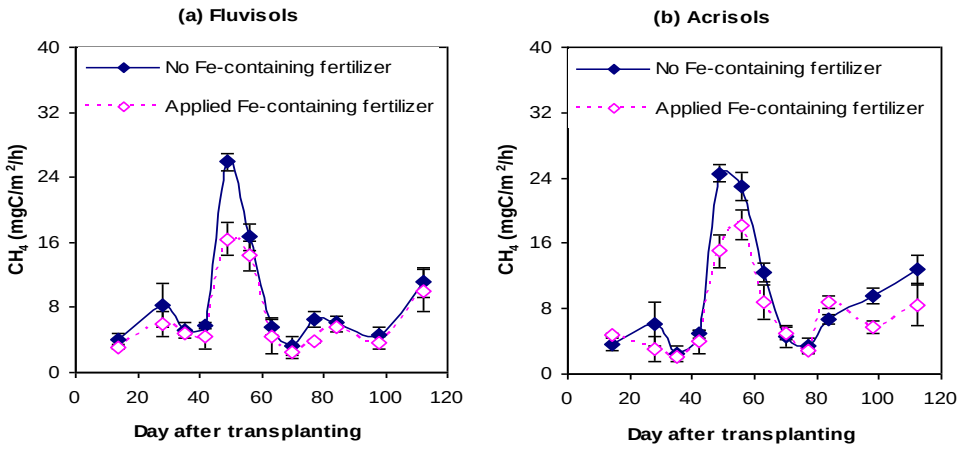


Figure 5. CH_4 emission over growth stages of rice grown on Fluvisols and Acrisols in spring 2009 (a: Fluvisols, b: Acrisols). Pham Quang Ha et al. 2013

10 GHG emission in rice production as affected by irrigation technique

In rice based cropping systems, it seems that non-continuous flooding reduces significantly CH_4 emission in rice production and the exact values are depend not only on the soil types; soil carbon and clay content but also rice variety and cropping season.

Several studies on alternative wed and dry (AWD) techniques indicated a great amount of water can be saved in irrigated rice production as well as GHG will be reduced in cases of AWD. Quyet and Wassman (2010) reported a reducing of 49% CH_4 emission in comparison with continuous flooding techniques.

Table 23. GHG emission as affected by soil type and water regime

items	Continuous flooding		AWD	
	Clay soil	Sandy soil	Clay soil	Sandy soil
CH4 (Gg C yr-1)	972.0	1,607.0	497.0	819.0
N2O (Gg N yr-1)	16.0	72.0	34.0	104.0
GWP (Gg CO2 yr-1)	37,238.0	82,708.0	31,289.0	73,611.0

Source: Quyet and Wassman (2010)

11. Promising solution options

As part of solution to adaptation and mitigation response to climate change in rice production, there are a list of promising options we may consider in crops productions such as integrated crop management (ICM); System Rice Intensification modified (SRI modified); minimum tillage; re-use crop residues; mix cropping in crop production . These promising options not only sustain agricultural productivity but also contribute to mitigate climate change; the extension capacity depends on each local condition (Pham Quang Ha, 2011).

CONCLUSION

The paper presented here is based on a synthesis approach showed organic carbon content in main group of Vietnam soil under agricultural activities. It is very much relative with C-sequestration and will contribute to GHG mitigation Crop production. Vietnamese experiences on sandy soil management to improve soil productivity as well as carbon stock in soil were quite clear. As the situation is complex , improvement carbon stock in light soil textures, low carbon content such as sandy soil is time consuming biological process. The management of these soils requires integrated practices that can increase fertility, and the

nutrient and water holding capacity of these soils. Biological management of these soils can be an effective way to increase soil quality through management of biomass, i.e. farmyard manures, crop residues, green manures, and alley cropping. In addition, the effective management of these soils needs careful consideration of appropriate techniques to address not only the issue of low productivity, but to also protect the environment. These soils are liable to significant losses of nutrients through leaching, so that any intensification of production needs to recognize this potential adverse effect and develop management strategies that minimize off-site pollution. These technologies need to be assessed in pilot demonstration plots under local conditions prior to recommending their adoption by the wider agricultural community. Policy to improve carbon stock in soils should go together with the improvement of the farmers' livelihood. Promising solution should be taken is to reduce the amount of chemical conventional fertilizers application (10-15%) and to use environment friendly nutrients from organic and inorganic sources, to develop and use new type and new technique of fertilization such as bio-char, wet and dry alternative irrigation in rice production integrated with minimum tillage and mix cropping systems. There is a great potential for development of a smart- rice production with different technical mitigation options when considering environmental payment services such as green economy development in agricultural sectors, especially in rice production but it need more calibration of the available methods and models for estimation and measurements of GHG mitigation at field and farm gate scales ./.

References

1. General Statistic Office (Vietstat). 2008. Annual Statistics of Vietnam. 2008. Hanoi.
2. Hoang Thi Thai Hoa. Soil Characteristic, cropping patterns and use of organic resources in coastal sandy area of ThuaThienHue province, Central Vietnam. PhD. Thesis. UCL. Belgium. 2008. 287p.
3. Mai Van Trinh, Tran Van The, Bui Phuong Loan, 2013. Potential to mitigate GHG emissions from rice production in Vietnam. . Journal of Agriculture and Rural Development. N. 3/2013. Page 64-70.
4. MONRE, 2010. Vietnam's second national communication to the United Nations framework convention on climate change. Hanoi. 2010
5. Nguyen Thuc Thi, 2003. Land use planning for sandy soil in Northern Province of Vietnam. NIAPP Project report, 2003. 42 p
6. Nguyen Van Bo, Ernst Mutert, Cong Doan Sat. 2003. Balanced Fertilization for Better Crops in Vietnam. Potash & Phosphate Institute (Southeast Asia Programs), 2003.141p.
7. Pham Quang Ha, 2011. Irrigated Rice Civilization and Climate change. Journal of Agriculture and Rural Development. N. 4/2011. Page 14-20.
8. Pham Quang Ha, 2011. Study on Mitigation options in Vietnamese Agriculture sectors. IAE Project report. Funded by Jica.
9. Pham Quang Ha, Vu Thang, Nguyen Thi Thom, Nguyen Thi Khanh, Kimio Ito, Koichi, Kazuyuki Inubushi. 2013. Assessment of CH_4 emission from rice growing on Fluvisol and Acrisols in North Vietnam. Vietnam journal of Agriculture and Rural Development. N. 3/2013. 37-40.
10. Pham Quang Ha (2013). A climate-smart rice production in Vietnam. Promising GG mitigation option. Communication in Taichung, FFTC-TARI workshop, 12-14 August. 2013.
11. Pham Quang Ha, Nguyen Van Bo, 2013. Fertilizer used in relation to food production, environmental protection and mitigation of greenhouse gas emission. Vietnam journal of Agriculture and Rural Development. N. 3/2013. 41-46.
12. Phan Lieu, 1981. Coastal sandy soil of Viet Nam. Science and technology publishing house. Ha Noi, 1981. 340 p.
13. Vietnam Soil Association (Vietsoil), 1996 . Vietnam soil. Agriculture publishing house. Ha Noi, 1996. 168 p.

14. Vu Manh Quyet; Wassman R. (2010). GHG emission in rice cultivation in Vietnam. International Rice Research Institute (IRRI), No 4698 in World Rice Congress, Hanoi, 2010..
15. Vu Nang Zung , Nguyen Tuan Anh, Nguyen Dinh Dai, 2005. Evaluation on costal sandy soil of Vietnam and its projection of use by 2010.

Vietnam -2

A CLIMATE-SMART RICE PRODUCTION IN VIETNAM. PROMISSING GHG MITIGATION OPTIONS

Pham Quang Ha,
Present Address: Institute for Agricultural Environment (IAE), Vietnam Academy of Agricultural Sciences (VAAS), Phu Do, Tuliem, Hanoi, Vietnam, E-mail: haphamquang@fpt.vn; pqha-nisf@hn.vnn.vn

ABSTRACT

Agriculture plays a very important role in Vietnam economy with more than 70% engaged population and 20-24% in GDP. Signs of climate change affected agriculture production and farmer's income have been identified not only by scientists but by both local authorities and farmers.

A recent overview of rice production in Vietnam (Pham Quang Ha, 2011) reported that, over last 50 years (1960-2010), rice production in Vietnam was increased in both crop yield (2.51 times), cultivated area (1.53 times) and therefore rice production was increased by 3.84 times. Vietnam produced today more than 35.53 million ton of rice per year in total of 43.2 million ton of grain food. This provided enough food more than 85.6 million Vietnamese and contributed to world food security. Vietnam is now the second world rice exporter with a total about 4-5 million tons of rice annually. As rice production areas in Vietnam are located mainly in Mekong River Delta (MRD) (51%) and Red River Delta (15%), these zones are considered the most affected by climate changes, in which, high sea level rises have been forecasted. With the worse cases, in 2100, more than 1.1 million ha of rice land in MRD will be deeply submerged and some thousands hectares of rice land in RRD will be salted. In addition, extreme climate such as heavy storms, irregular rainfalls distribution; droughts, unpredicted disease epidemics are big challenges for Vietnam to keep a stable rice production in the end of this century.

Different measures and actions were considered and taken in Vietnam. Both adaptation and mitigation options were mentioned. It is hopefully that Vietnam can take over the new challenges in the coming decades to reach successfully the target of 3.8 millions ha of soils for rice with a production annually of 43 millions ton of rice as formulated by the year 2020.

Promising solution should be taken is to reduce the amount of chemical conventional fertilizers application (10-15%) and to use environment friendly nutrients from organic and inorganic sources, to develop and use new type and new technique of fertilization such as bio-char, wet and dry alternative irrigation in rice production integrated with minimum tillage and mix cropping systems

Keywords**:** *Climate change, smart, rice production, GHG, mitigation, Vietnam*

INTRODUCTION

Agriculture plays a very important role in Vietnam economy with more than 70% engaged population and 20-24% in GDP. Signs of climate change affected agriculture production and farmer's income have been identified not only by scientists but by both local authorities and farmers. A recent overview of rice production in Vietnam (Pham Quang Ha, 2011) reported that, over last 50 years (1960-2010), rice production in Vietnam was increased in both crop yield (2.51 times), cultivated area (1.53 times) and therefore rice production was increased by 3.84 times. Vietnam produced today more than 35.53 million ton of rice per year in total

of 43.2 million ton of grain food. This provided enough food more than 85.6 million Vietnamese and contributed to world food security. Vietnam is now the second world rice exporter with a total about 4-5 million tons of rice annually. As rice production areas in Vietnam are located mainly in Mekong River Delta (MRD) (51%) and Red River Delta (15%), these zones are considered the most affected by climate changes, in which, high sea level rises have been forecasted. With the worse cases, in 2100, more than 1.1 million ha of rice land in MRD will be deeply submerged and some thousands hectares of rice land in RRD will be salted. In addition, extreme climate such as heavy storms, irregular rainfalls distribution; droughts, unpredicted disease epidemics are big challenges for Vietnam to keep a stable rice production in the end of this century.

With respect to environment, rice fields are among the major sources of atmospheric CH_4, the second important greenhouse gas contributing to global warming.

Previous studies on mechanism of CH_4 emission from rice paddy have shown that CH_4 in paddies soils is biologically produced by acetate fermentation or carbon dioxide reduction by hydrogen. A portion of the produced CH_4 is oxidized in soils by methanotrophs and the remainder is mostly emitted to the atmosphere. Physico-chemical properties of soil (e.g. redox potential, supply of and competition for substrates, temperature), regional climate condition, cropping season and crop management including cultivar using, irrigation and particularly fertilizer properties and application method are the major factors affecting rate of CH_4 emission from flooded rice paddies. Evaluation of CH_4 emission potential of different rice production systems is therefore required.

In awareness with climate change, Vietnam has actively taken action to reduce impact of climate change. Vietnam Government issued the National target program to respond to climate change in 2008 (QD 158/2008-TTg, 02/12/2008); Scenarios of Climate Change and Sea Level Rise in Vietnam (MONRE, 2010); Ministry of Agriculture and Rural Development (MARD) issued the Promulgation of the Climate Change Adaptation Framework Action Program in the 2008 – 2020 period, and overall goal was set to maintain stable agricultural production and food security including ensure 3.8 million hectare for paddy rice production (Decision No. 2730/2008/QD-BNN-KHCN, MARD, 2008). Accompany with above policy, Vietnam has been implementing several projects to support local people to better off their capacity to reduce vulnerability due to climate change. In agriculture, there are several techniques/practices options can be developed and implemented to respond for both adaptation and mitigation of climate change.

MATERIAL AND METHODS

Monitoring on soil and fertilizers uses for different soils types and different cropping were conducted by Viet Nam Soil Monitoring Station since 1998. This work is conducted now annually by the stations belonging to the Institute for Agricultural Environment (IAE/VAAS).

Calibration and monitoring and estimation of the CH4 emission from rice field was also conducted under different condition of water regimes and fertilizers treatments (Pham Quang Ha et al. (2009-2012) for acrisols and for fluvisols.

DNDC model was also adapted to estimate GHG emission from different cases in agriculture sectors as reported in **"**An estimation of GHG reduction potential for agriculture sector in Vietnam**"** (Mai Van Trinh et al. 2012)

A global review of possible mitigation options in Vietnamese agriculture as well as three cases study such as the bottle-neck study on system rice intensification (SRI); Bio-digester/biogas technologies (Bio-gas) and the development study on mix-cropping and minimum tillage were conducted in 7 agro-ecological zones including 20 selected provinces

of Vietnam (HoaBinh, PhuTho, ThaiNguyen, HaNoi, HaNam, NgheAn, HaTinh, ThuaThien-Hue, QuangTri, KhanhHoa, NinhThuan, LamDong, DacLak, KonTum, DongNai, BinhDuong, BinhThuan, BenTre, TienGiang) (Pham Quang Ha, 2011).

FINDINGS

1. Rice production in Vietnam relative with fertilizer uses and efficiency

Table. Food production, Crop yields and fertilizer uses in Vietnam

Year	Food (10^6 T)	Rice Yield (T ha^{-1})	Coeff. Increasing	Maize Yield (T ha^{-1})	Coeff. Increasing	NPK Used (10^3T)
2000	34,5	4,24	1,00	2,74	1,00	2283
2005	39,6	4,88	1,15	3,59	1,31	2071
2010	44,6	5,34	1,26	4,10	1,50	2090

Source: GSO (2010)

Since past 40 years, fertilizers uses in Vietnam were dramatically increased both in inorganic and organic sources. Today, the amount of chemical fertilizers used has excesses 260 units of NPK per ha but its efficiency remains still very low. About 40 to 60 percent of fertilizers unit were loosed. Economically it makes a loss of several hundred of million US dollars annually for national economy and consequently it will disparate in the nature and make the environment become more polluted, more GHG emitted.

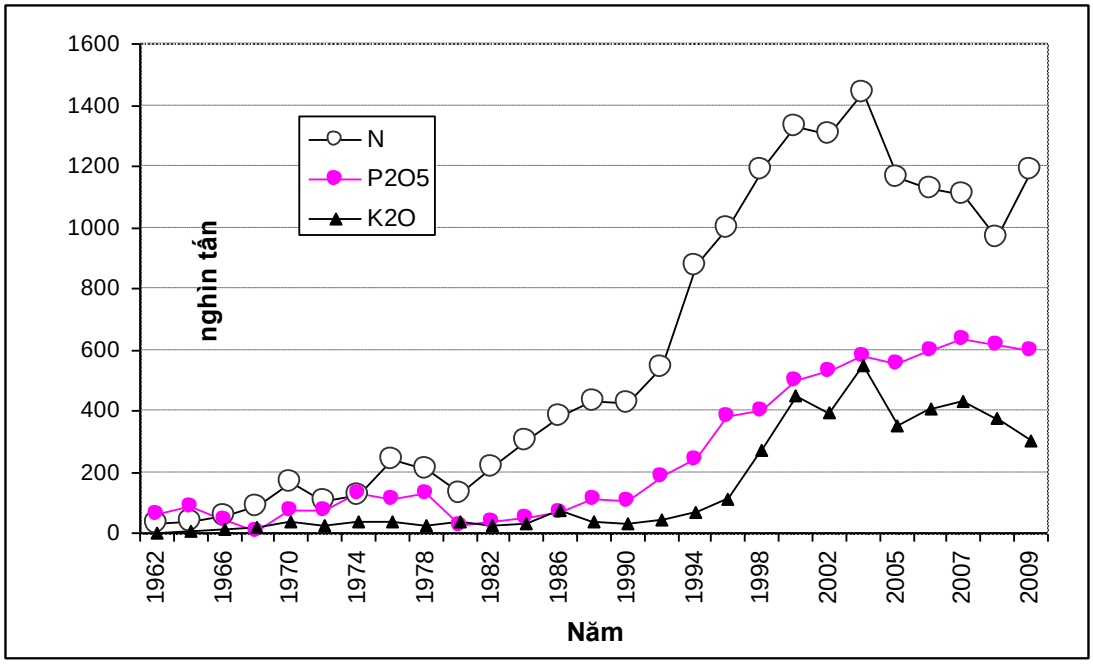


Figure 1: fertilizer uses in Vietnam (FAO, Stat, 2011), 10^3 T NPK

Table : Fertilizer uses efficiency in some selective crops

Crop/Soil	Efficiency (%)		
	N	P	K
Spring Rice/Fluvisol	43	21	46
Summer Rice/Fluvisol	36	22	43
Spring Rice/Acrisols	12-50		45
Summer Rice / Acrisols	16-56		
Coffee /Ferrasols		20-36	30
Vegetables /Fluvisols	33-60		20

Sources: Pham Quang Ha and Nguyen Van Bo (2013)

2. GHGs emission from Vietnamese agriculture sectors

GHGs emission from Vietnamese agriculture sectors was estimated for 2000 data as great as 43.1% of the total emission from Vietnam (about 65.1 million tones of CO_2e). In which, rice cultivation contributes 57.5%, livestock contribute about 5.3%, enteric fermentation accounts for 11.9% of total GHGs emission from agriculture. Total GHG emissions were also projected for 2010, 2020 and 2030. Emissions from Agriculture sectors will be relatively great as 169.2 M; 300.4 M and 515.8 M tones of CO_2 e. (MONRE, 2010).

Table 1. GHG emission in Vietnam (10^3T)

Sector	CO_2	CH_4	N_2O	CO_2 e	Percent (%)
Energy	45,900.00	308.56	1.27	52,773.46	35.0
Industry	10,005.72	0	0	10,005.72	6.6
Agriculture	0	2,383.75	48.49	65,090.65	43.1
LULUCF	11,860.19	140.33	0.96	15,104.72	10.0
Waste	0	331.48	3.11	7,925.18	5.3
Total	67,765.91	3,164.12	53.83	150,899.73	100

Source: Vietnam Second Communication to UNFCC (MONRE, 2010)

Table2. GHG emission from Vietnam Agriculture Sectors (10^3T)

Sub-sectors	CH_4	N_2O	CO	NOx	CO_2 e	(%)
Fermentation	382.12				7,730.52	11.9
Fertilizer use	164.16				3,447.36	5.3
Rice Prod.	1,782.37				37,429.77	57.5
Land use		45.87			14,219.70	21.8
Burning Savanna	9.97	1.23	261.71	4.46	590.67	0.9
Agr. Waste	59.13	1.39	1,241.68	50.28	1,672.63	2.6

Source: Vietnam Second Communication to UNFCC (MONRE, 2010)

3. Measurement of methane emission in Rice production

The level of greenhouse gas emissions depend heavily on cultivation mode, the plant watering regimes, and the use of fertilizers. More recent research results show that the alternative irrigation (AWD) not only saves water but also reduces greenhouse gas emissions. Balanced fertilization, using new materials (Bio-char enriched, Fe, etc.) can also increase rice productivity together with reduce greenhouse gas emissions, including CO_2, CH_4 and N_2O.

In our experiments, high peak of CH_4 emission rate appeared at 30 – 60 days after transplanting. It may reach more than 70 mg C/m2/hr for spring rice in fluvisol since 6 weeks after transplanting and 87 mg C/kg/hr in acrisol since 8 weeks after transplanting and than decrease. For Summer rice, figure are different, the maximum absolute rate may reach since 4 weeks after transplanting in fluvisol, but the maximum absolute value was only 27 mg C/m2/hr and the maximum value found in acrisols was 37 C/m2/hr in 6 week after transplanting. CH_4 emission rate from rice soil applied Fe-containing fertilizer trended lower than that from rice soil without Fe-containing fertilizer. Cumulative CH_4 emission rate both two rice seasons from fluvisols and acrisol was decreased by more than 20 % ($p < 0.05$) in comparison with no application of Fe-containing fertilizer.

Table3. Cumulative CH_4 emission over rice season on Fluvisols and Acrisols in pot in spring 2009 (mgC/m²/season)

Treatment	Fluvisols	Acrisols
No application of Fe-fertilizer	20032	23293
Application of Fe-fertilizer	15733	18050
GHG decreasing (%)	21.5	22.5

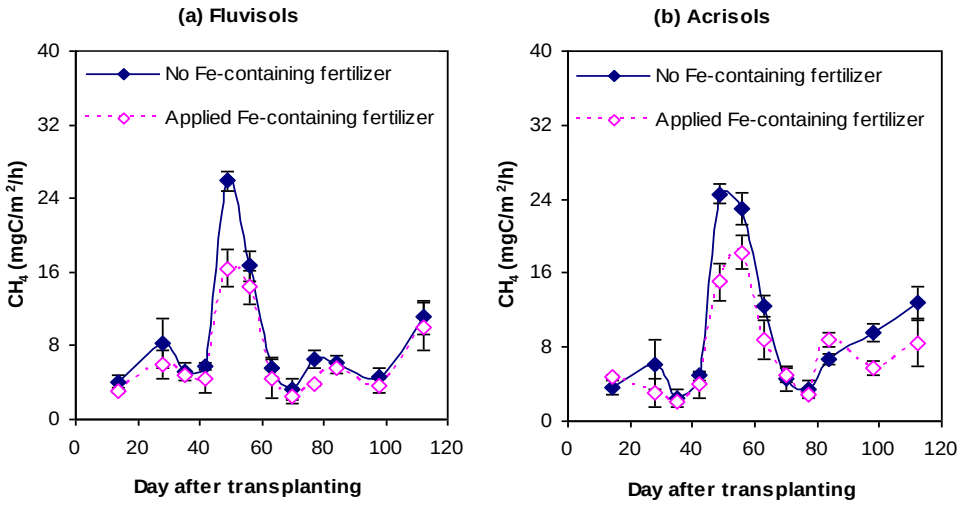


Figure 2. CH_4 emission over growth stages of rice grown on Fluvisols and Acrisols in spring 2009 (a: Fluvisols, b: Acrisols). Pham Quang Ha et al. 2013

4. GHG emission in rice production as affected by irrigation technique

In rice based cropping systems, it seems that non-continuous flooding reduces significantly CH_4 emission in rice production and the exact values are depend not only on the soil types; soil carbon and clay content but also rice variety and cropping season.

Table 4. GHG emission as affected by soil type and water regime

items	Continuous flooding		AWD	
	Clay soil	Sandy soil	Clay soil	Sandy soil
CH4 (Gg C yr-1)	972.0	1,607.0	497.0	819.0
N2O (Gg N yr-1)	16.0	72.0	34.0	104.0
GWP (Gg CO2 yr-1)	37,238.0	82,708.0	31,289.0	73,611.0

Source: Quyet and Wassman (2010)

Several studies on alternative wed and dry (AWD) techniques indicated a great amount of water can be saved in irrigated rice production as well as GHG will be reduced in cases of AWD. Quyet and Wassman (2010) reported a reducing of 49% CH_4 emission in comparison with continuous flooding techniques.

5. Promising solution options

As part of solution to adaptation and mitigation response to climate change in rice production, there are a list of promising options we may consider in crops productions such as integrated crop management (ICM); System Rice Intensification modified (SRI modified);

minimum tillage; re-use crop residues; mix cropping in crop production . These promising options not only sustain agricultural productivity but also contribute to mitigate climate change; the extension capacity depends on each local condition (Pham Quang Ha, 2011).

CONCLUSION

It is hopefully that Vietnam can take over the new challenges in the coming decades to reach successfully the target of 3.8 million ha of soils for rice with a production annually of 43 million ton of rice as formulated by the year 2020.

Promising solution should be taken is to reduce the amount of chemical conventional fertilizers application (10-15%) and to use environment friendly nutrients from organic and inorganic sources, to develop and use new type and new technique of fertilization such as bio-char, wet and dry alternative irrigation in rice production integrated with minimum tillage and mix cropping systems. There is a great potential for development of a smart- rice production with different technical mitigation options when considering environmental payment services such as green economy development in agricultural sectors, especially in rice production but it need more calibration of the available methods and models for estimation and measurements of GHG mitigation at field and farm gate scales.

REFERENCES

Mai Van Trinh, Tran Van The, Bui Phuong Loan, 2013. Potential to mitigate GHG emissions from rice production in Vietnam. . Journal of Agriculture and Rural Development. N. 3/2013. Page 64-70.

MONRE, 2010. Vietnam's second national communication to the United Nations framework convention on climate change. Hanoi. 2010

Pham Quang Ha, Vu Thang, Nguyen Thi Thom, Nguyen Thi Khanh, Kimio Ito, Koichi, Kazuyuki Inubushi. 2013. Assessment of CH_4 emission from rice growing on Fluvisol and Acrisols in North Vietnam. Vietnam journal of Agriculture and Rural Development. N. 3/2013. 37-40.

Pham Quang Ha, 2011. Study on Mitigation options in Vietnamese Agriculture sectors. IAE Project report. Funded by Jica.

Pham Quang Ha, 2011. Irrigated Rice Civilization and Climate change. Journal of Agriculture and Rural Development. N. 4/2011. Page 14-20.

Vu Manh Quyet; Wassman R. (2010). GHG emission in rice cultivation in Vietnam.
International Rice Research Institute (IRRI), No 4698 in World Rice Congress, Hanoi, 2010.

Appendix 8: Five-Year ASOCON Regional Action Programme for Sustainable Land Management in Asia [2014-2018]

NOTES FOR A FIRST DRAFT

3. Introduction

What is about this document*?*

ASOCON Regional Action Programme for SLM is the roadmap for intensifying regional cooperation on SLM information exchange, regional experts' consultation, and learning activities to enhance the skills and expertise of those responsible for the development and dissemination of soil and water conservation for small farmers. It provides the regional platform for bridging the knowledge gaps on SLM and contributes to the regional action program on combating DLDD. ….ADD TEXTS ON (What is the plan itself to help member countries, its significance?), The process of the preparation of the plan- product experts consultation, distinction between ASOCON action Program and RAP?)

Link with three conventions and how this link to scope of ASOCON

Cross-cutting activities within the three Conventions are awareness raising, advocacy campaign, capacity building, and exchange of knowledge. Within the scope of regional cooperation, the Regional Action Program will put these efforts together to address common issues of the three Conventions. With the threats of climate change, **UNFCCC** identifies adaptation measures to increase resilience and coping capacity of affected sectors. In this case, while **UNCCD** addresses the impacts of extreme climate events (i.e including drought) on land and soil, its interventions could be translated into climate change adaptation and mitigation platform particularly for the agriculture and natural resources. Changes in natural ecosystems productivity threaten biodiversity and therefore combating DLDD through **UNCCD** will help ensure natural resources productivity and maintain ecosystems services for **CBD.**

The three Conventions, therefore, can work together at the regional level with ASOCON providing the pathways for cooperation through its strong cooperative arrangements between its member countries and its long collective experience in soil and water conservation. However, at present it lacks a regional action program that will sustain and provide clear direction for ASOCON to move two-step forward. Hence, it is important to develop this program to enhance regional convergence of actions towards a broader adoption of soil and water conservation practices and ultimately help small-scale farmers, the most vulnerable sector to climate change, use their land productively and sustainably within the region.

(This action program will help facilitate the mainstreaming of LD issues into the national policy and program)

4. National action programmes (NAPs) to combat land degradation in the context of climate change and biodiversity loss

Key issues and priority of country in the region (taken from country presentations, synthesised and summarized)

- Based on consultation, national priorities have been identified. Regional action plan will be prepared in line with ASOCON framework

- What other countries have done so far
- Determine common issues and link with ASOCON

5. Objectives of regional cooperation

Based on country reports and in line with the operational objective of ASOCON the following are the key objectives of RAP:

vi. Strengthen regional cooperation to address the common issues
vii. Advocacy, awareness raising, (visibility) and education – to influence policy and decision makers
viii. Support the formulation of enabling policy for implementation
ix. Update and documentation of knowledge on climate change and its impact
x. Capacity Building and technology transfer – identify and address capacity building needs
xi. Resource mobilization and financing

6. Priority areas of regional cooperation (Food and livelihood security): Review after looking on the Country Presentation in (2)

Where these priorities came from? Thematic Areas with respect to the three Conventions. This will encompass three main focal areas LD, CC and BD with detailed list of interventions, activities. Brief description of these priorities areas and their related activities are described as follows:

A. Land degradation/desertification

The main activities under this thematic area are listed below:

i. Improvement of water use/management (include IWRM: on—farm vs off-farm) - this intervention aim..... for the efficient use of water resources considering climate change and related disasters.
ii. Combating soil erosion – through collaborative watershed management including bio-engineering soil and water conservation practices the vegetation cover will be maintained in critical watersheds which will contribute to accelerated soil erosion and enhance on-site productivity and regulate surface runoff and sediment load at reasonable level. Maintain and/or improve soil fertility.
iii. Address land tenure issues – clear land tenure system is a key to SLM and soil and water conservation works; RAP will consolidate of best land tenure system will provide guidance to member countries to fit and adopt to local condition. In this regard, land tenure is the most problematic and medium to long term interest and the results and focuses getting as much benefits as possible in a short period of time (e.g. rangeland, they utilized but without any arrangement or plan of managing it). To be address through policy and operational level. Landowners are land users themselves (vs. Landless).
iv. Land use planning – proper land use planning the conversion of agriculture land will be minimized and the same time the conversion of one land use to other unsustainable uses. For this purpose, land zoning will be the first step. Require strict implementation of related policies.
v. Agro-forestry and management of forest resources and watersheds management (collaborative approach, new generation approach)- by promoting farm forestry and agro-forestry in private and communal land will reduce

pressure on the natural forest in terms of fuel wood, timber fodder thus less threat to the natural forest cover.

vi. Reduced water logging and salinity – on farm water management through proper irrigation and drainage system

vii. Pasture/range land management – vast resources, community –managed and generally affected by drought and desertification, proper management will lead to a big percentage of sustainably managed land resource.

viii. Labour saving technology and make agriculture attractive – efforts should be made to make agriculture economically attractive; move from subsistence to more productive agriculture through encouragement and promotion of conservation agriculture

B. Climate change

Due to the current climate change the future agriculture dimension will change which will affect food security and livelihood of the poor and vulnerable people. In order to better cope with the changing situation the following key activities;

xi. Establishment of early warning systems/climate resilient agriculture - for better response through appropriate preparedness and mitigation measures will functional warning systems would be essential to better prepare local communities to reduce the negative impact of climate change. In this regard community based disaster risk reduction will be a useful tool. Adoption of climate smart agriculture will be a good approach.

xii. Economic capacity building of local communities – For disaster resilient communities the economic empowerment is a key to better prepare in disaster especially climate change. The capacity should be built in advance preparation as well as preparing and implementing comprehensive responses.

xiii. Alternative livelihood sources (diversification of production systems; entire value chain from input supply to processing) to minimize risks – in order to reduce the risk the key approach should be diversification of income livelihood opportunities so that the poor farmers do not suffer huge losses in case of any negative impact of climate change.

xiv. Avoiding deforestation – to maintain the productive and protective services of the forestry ecosystem large scale deforestation should be avoided.

xv. Improvement soil as carbon sink (increased organic matter content); how to convince farmers to adopt or contribute to the efforts, economic advantage – this will basically requires both awareness raising and technology transfer to the local farmers. This will also help carbon trading besides increasing onsite productivity of agriculture land.

C. Biodiversity loss

Coupled with the land degradation of the forestry ecosystem there are huge losses to the biodiversity. Therefore, maintaining and managing good crops and vegetation cover, species composition, plant and animal resources will encourage and enhance biodiversity. Key areas of intervention include the following;

vii. Valuation of ecosystem services/development of eco- and ethno-tourism – this is a new concept which is yet to be adopted by the member countries. However, it will require good techniques for putting money values for various product and services from a given ecosystem including biodiversity. This should be reflected in the country policy and strategy for nature resource management and conservation. The regional network like ASOCON can provide

technical backstopping on this concept and also contribute to the capacity building needs.

viii. Economic capacity building of local communities - The expected biodiversity losses can be substantially reduced if the depending communities are engaged in productive and economic activities to meet their livelihood needs as alternative livelihood options.

ix. Promote ecosystem based agriculture – GIAHS , IPM CA are among the key approaches to get better outputs from the given resource production and function according to the specific situation.

7. Instruments for solving regional problems

5.1 Pilot projects

1. Streamlining information flow within the region and conduct information gap analysis and build capacity
2. Identify and collect information on best soil and water conservation technologies and develop a compendium. Identify the gaps and bottle necks for up-scaling the best practices
    a. **Information generation–** Benchmark studies, coordination with universities, national research institutes, NGO networks, Local authority networks, etc.
    b. Extension service(s), explore mass media in target countries, Special publications and dissemination, information transfer through SMS in mobile telephone systems, etc.
    c. Financial disbursements and completed outputs
    d. Discussion with and data collection from user groups and site visits
    e. Monitoring livelihood status changes
    f. Impacts on socio-economic situations

3. Information sharing - Enhance the existing website, cooperation among local and regional networks, support information needs and empower national agricultural agencies for information holding and sharing
   Enhance information sharing on desertification, land degradation and drought management in the region through
    a. ASOCON Flagship Newsletter (e.g. Contour)
    b. Strengthening regional capacity by linking national ASOCON member countries websites (including translation?)
    c. Regional symposium and seminars
    d. Making available useful SLM information from within and beyond the region/ SLM sectors
    e. Networking among the organizations, institutions in target countries, INGOs (such as creating and maintaining the directory of experts and practitioners)

4. Identify the existing and emerging networks and facilitate the national networks to link with regional networks to contribute to RAP
5. Support in the establishment of early warning systems and synergizing the existing activities
6. Prepare and maintain a directory of (professionals, researchers and practitioners, associations in the three thematic areas. Linking technical services within the region **Provide policy recommendations on SLM to regional bodies (ASEAN, SAARC), and international organizations**

5.2 Strategy for formulation and implementation

5.2.1 Partner with existing networks, donors, and Research, Development and Extension Networks as well as similar sections of financial institutions for seeking cooperation and synergy among them for solving problems mentioned above using Technical Cooperation Projects (TCPs) and Donor-funded regional projects, etc.

5.2.2 Implementation modalities: Roles and responsibilities of the different actors.

5.2.3 Timeframe

5.2.4 Proposed budgets

5.2.5 Mobilization of financial resources

The following institutions, organizations and any potential contributors could be explored for this purpose.

a. Campaign through country governments to provide financial support
    - Appointment of country members for ASOCON and communicate with country governments for possible financial and in kind assistance for projects.
b. Seek funds from country governments and external donors, such as FAO, ADB, World Bank, AusAID, IFAD, GTZ, Private Sector, Private markets, Multi-national Companies, etc.
c. Partner with UNCCD and the Global Mechanism (GM)

Engagement of volunteer services by relevant experts in collaboration with the UN Volunteer Program (UNV) and other national Volunteer service organizations (VSOs).

5.2.6 Role of non-governmental and public organizations and local administrative bodies in informing, designing and implementation of ASOCON activities

a. Contribution to the network of ASOCON in terms of piloting, awareness creation, technology transfer, monitoring and evaluation is expected. Some examples would be
    - Mongolia's cooperation with Japan and Chinese Grassland Association for pasture management;
    - Ministry of Interior closely associating with Sub-district leaders for implementation support, monitoring and evaluations.
    - LDD Soil Doctor Program in Thailand

5.2.7 Monitoring and evaluation

- M&E of SLM situation and practices
    a. Monitoring livelihood status changes
    b. Impacts on socio-economic situations
    c. Through the discussion with user groups and site visits, and the use of following tools,
    - Use of early warning system for extreme events
    - Remote sensing and GIS for slow and fast changing situations
    - Risk assessments
    d. Long term changes in the ecosystem covering soil degradation and water resources.

- **M & E of ASOCON programs and activities**
  a. Annual in-house review in regional and country level
  b. Local government/local authority initiatives in sustainable agriculture and climate smart agriculture
  c. Field laboratory for soil and water conservation in Indonesia
  d. National conservation agriculture/farming movements and their NGO partners could also provide assistance for implementation and monitoring of ASOCON activities.