

ENVIRONMENTAL IMPACT ASSESSMENT
(SPECIAL INVESTIGATION)
ON
HYDROPOWER DEVELOPMENT OF
AYEYAWADY RIVER BASIN ABOVE MYITKYINA,
KACHIN STATE, MYANMAR

Biodiversity And Nature Conservation Association (BANCA)



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Yangon

MYANMAR

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Part - I

ACRONYMS AND ABBREVIATIONS

BANCA	Biodiversity And Nature Conservation Association
BIA	Biological Impact Assessment
BOT	Build, operate, and transfer
CAS	California Academy of Science
CBD	Convention on Biological Diversity
CISPDR	Changjiang Institute of Survey, Planning, Design & Research
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on Migratory Species
CPD	Center of Plant Diversity
CPI	China Power Investment Corporation
CR	Critically Endangered
DBH	Diameter at Breast Height of a plant
DD	Data Deficient
DHPI	Department of Hydroelectric Power Implementation
EIA	Environmental Impact Assessment
EN	Endangered
EIS	Environmental Impact Statement
EW	Extinct in the Wild
EX	Extinct
FD	Forest Department
GPS	Global Positioning System
IUCN	The World Conservation Union (International Union for Conservation of Nature and Natural Resources)
IVI	Important Value Index; a quantitative analysis of dominant species and their relative values of frequency, density and basal area were calculated and summed up to get important value index.
KIA	Kachin Independent Army
kW	Kilowatt
kWh	Kilowatt hour
LC	Least Concerned
MDG	Millennium Development Goals
MOGE	Myanmar Oil and Gas Enterprise
MW	Megawatts
mg/l	Milligram per liter
NCNPP	Nature Conservation and National Park's Project

NCEA	The National Commission for Environmental Affairs
NDAK	New Democratic Army of Kachin
NP	National Park
NT	Near Threatened
NTFP	Non Timber Forest Product
NTU	Nephelometric Turbidity Unit
NWCD	Nature and Wildlife Conservation Division
PAS	Protected Areas System
ppm	Parts per Million
SI	Smithsonian Institution
TCM	Traditional Chinese Medicine
TKM	Traditional Korean Medicine
TRAFFIC	Wildlife trade monitoring network
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
USNM	Natural Museum of Natural History, Smithsonian Institution
uS/cm	Micro siemens Per Centimeter
VU	Vulnerable
WCD	World Commission on Dams
WCS	Wildlife Conservation Society
WS	Wildlife Sanctuary
WWF	World Wide Fund For Nature

GLOSSARY OF MAJOR TERMS USED IN PART I, PART II AND PART III OF THIS REPORT

Abatement	Reducing the degree or intensity of, or eliminating pollution.
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Absorption	The passage of one substance into or through another; an operation in which one or more soluble components of a gas mixture are dissolved in a liquid.
Accident site	The location of and unexpected occurrence, failure, or loss, either at a plant or along a transportation route, resulting in a release of hazardous materials.
Acid deposition	A complex chemical and atmospheric phenomenon that occurs when emissions of sulfur and nitrogen compounds and other substances are transformed by chemical processes in the atmosphere, often far from the original sources, and then deposited on earth in either a wet or a dry form.
Acute toxicity	The ability of a substance to cause poisonous effects resulting in severe biological harm or death soon after a single exposure or dose; also any severe poisonous effect resulting from a single short-term exposure to a toxic substance.
Adit	A tunnel used, made for geological investigations.
Aerobic	Life or processes that require, or are not destroyed by the presence of oxygen.
Agricultural Pollution	A liquid and solid wastes from farming, including runoff and leaching of pesticides and fertilizers; erosion and dust from plowing; animal manure and eareassess; and crop residues and debris.
Air Pollution	The presence of contaminant or pollutant substances in the air that do not disperse properly and interfere with human health or welfare or produce other harmful environmental effects.
Algae	A major division of the plant kingdom consisting of simple non-vascular photosynthetic plants which a unicellular, colonial, filamentous, or thalloid body, and being aquatic in marine or freshwater or found in damp habitats on land. Algae are a large and diverse group of simple, typically autotrophic organisms, ranging from unicellular to multicellular forms. The largest and most complex marine forms are called seaweeds. They are photosynthetic, like plants, and "simple" because they lack the many distinct organs found in land plants. For that reason they are currently excluded from being considered plants.
Ambient Air	Any unconfined protion of the atmosphere; open air, surrounding air.
Amphidromous	Amphidromous fish move between fresh and saltwater during their life cycle, but not to breed.

Anadromous	Anadromous fish live in the ocean mostly, and breed in freshwater.
Aquaculture	Aquaculture is the farming of freshwater and saltwater organisms including fish, molluscs, crustaceans and aquatic plants. Unlike fishing, aquaculture, also known as aquafarming, implies the cultivation of aquatic populations under controlled conditions.
Aquatic	Aquatic means relating to water; living in or near water or taking place in water.
Aquifer	An underground geological formation or group of formations, containing usable amounts of groundwater that can supply wells and springs.
Atmosphere (as a measurement)	A standard unit of pressure representing the pressure exerted by a 29.92 inch column of mercury at sea level at 45 degree latitude and equal to 1000 grams per square centimeter.
Bacteria (singular bacterium)	Microscopic living organism that can aid in pollution control by consuming or breaking down organic matter in sewage or by similarly acting on oil spills or other water pollutants.
Benthos	Benthos are the organisms which live on, in, or near the sea or inland water bed, also known as the benthic zone.
Biochemical Oxygen Demand (BOD)	A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. The greater the BOD, the greater the degree of pollution.
Biodiversity	All living things on Earth (plants, animals and micro-organisms), and the differences that make each species unique.
Biological Oxidation	The way bacteria and microorganism feed on and decompose complex organic materials; used in self-purification of water bodies and in activated sludge wastewater treatment.
Biological Treatment	A treatment technology that uses bacteria to consume waste and thus break down organic materials.
Cadmium (Cd)	A heavy metal element that accumulates in the environment.
Carbon dioxide (CO₂)	A colourless, odorless, nonpoisonous gas that results from fossil fuel combustion and is normally apart of the ambient air.

Carbon monoxide (CO)	A colourless, odorless, poisonous gas produces by incomplete fossil fuel combustion.
Carcinogen	Any substance that can cause or contribute to the production of cancer.
Carnivores	A carnivore is an animal that is adapted to eat meat and not plant.
Catadromous	Catadromous fish live in the freshwater, and breed in the ocean.
Catchment	The action of collecting water, especially the collection of rainfall over a natural drainage area.
Catchment Area	The area of land, in square kilometers (km ²) or hectares (ha), that drains to a specific point on a river.
Chemical oxygen demand (COD)	A measue of the oxygen require to oxidize all compounds in water, both organic and inorganic.
Chinese EIA Law	Law of the People's Republic of China on Appraising of Environment Impacts
Chlorofluorocarbons (CFCs)	A family of inert, nontoxic and easily liquefied chemicals used in refrigeration air conditioning, packaging, and insulation or as solvents and aerosol propellants.
Chromium	A heavy metal.
Chronic toxicity	The capacity of a substance to cause long term poisonous human healh effects.
CITES Appendix I	It includes just over 800 species threatened with extinction, and trade in specimens of these species is permitted only in exceptional circumstances (e.g., scientific study).
CITES Appendix II	It includes some 29,000 species that are not necessarily threatened with extinction, but in which trade must be controlled in order to avoid levels of utilization that would be incompatible with their survival.
CITES Appendix III	It contains 200-odd species that are protected in at least one country which has then asked other CITIES Parties for assistance in controlling the trade.
Coagulation	A clumping of particles in waste water to settle out imputities; often induced by chemicals such as lime, alum and iron salts.
Confluence	The junction of two or more rivers flowing together

Contaminant	Any physical, chemical, biological, radiological substance or matter that has an adverse affect on air, water, or soil.
Corrosion	The dissolving and wearing away of metal caused by a chemical reaction the occurs between water and the pipes that the water contracts, or when chemicals touching a metal surface, or when two metals are in contact.
Critically Endangered (CR)	Organisms with a conservation status of critically endangered have an extremely high risk of becoming extinct in the wild or completely extinct in the immediate future.
Critically Endangered SPecies	A species considered to be facing an extremely high risk of extinction in the wild, assessed using the IUCN Red List Categories and Criteria.
Cumulative	Increasing or growing by an accumulation or successive addition of parts or elements.
Dam	A concrete or earthen barrier constructed across a river and designed to control water flow or create a reservoir
Data Deficient (DD)	Data Deficient (DD) is a category applied by the IUCN to a species when the available information is not sufficient for a proper assessment of conservation status to be made. This does not necessarily indicate that the species has not been extensively studied; but it does indicate that little or no information is available on the abundance and distribution of the species.
Data Deficient SPecies	A species for which there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. Data deficient species are research priorities, but not necessarily conservation priorities.
DecomPosition	The breakdown of matter by bacteria and fungi; canges the chemical makeup and physical appearance of materials.
Degradation	The process by which a chemical reduced to a less complex form.
Diadromous	Diadromous fish travel between salt and freshwater
Discharge	A concrete or earthen barrier constructed across a river and designed to control water flow or create a reservoir.
Dissolved oxygen	Oxygen saturation or dissolved oxygen (DO) is a relative measure of the amount of oxygen that is dissolved or carried in a given medium. It can be measured with a dissolved oxygen probe such as an oxygen sensor or an optode in liquid media, usually water.

Dissolved solids	Disintegrated organic and inorganic material contained in water.
Diversion	The transfer of water from a stream, lake, aquifer, or other source of water by a canal, pipe, well, or other conduit to another watercourse or to the land, as in the case of an irrigation system
Downstream	Situated or moving in the direction in which a stream or river flows
Drawdown	The release of water from a reservoir for power generation, flood control, irrigation or other water management activity
Ecology	The study of interrelationships of organisms to their environment (or surroundings). Ecology considers individual organisms, populations, and communities, as well as large units of landscape such as forests, estuaries and river basins. For an EIA, the ecosystem can be considered to be an appropriate unit of analysis concerned with a community and its environment, both living and non-living.
Ecoregion	According to WWF (2002), ecoregion means, a large area of land or water that contains a geographically distinct assemblage of natural communities that share a large majority of their species and ecological dynamics, share similar environmental conditions, and interact ecologically in ways that are critical for their long-term persistence.
Ecosystem	<p>A community and its environment (living and nonliving considered collectively) (may range in extent from very small to very large units).</p> <p>An ecosystem is a natural unit consisting of all plants, animals and micro-organisms (biotic factors) in an area functioning together with all of the physical (abiotic) factors of the environment.</p>
Ecotourism	Tourism directed towards threatened natural environments, especially to support conservation efforts and observe wildlife.
Effluent	Wastewater treated or untreated that flows out of a treatment plant, sewer, or industrial outfall; generally refers to wastes discharged into surface water.

Electrical conductivity	Electrical conductivity or specific conductance is a measure of a material's ability to conduct an electric current. The conductivity of a solution of water is highly dependent on its concentration of dissolved salts and sometimes other chemical species which tend to ionize in the solution. Electrical conductivity of water samples is used as an indicator of how salt-free, ion-free, or impurity-free the sample is; the purer the water, the lower the conductivity (the higher the resistivity). Conductivity measurements in water are often reported as "Specific Conductance", which is the conductivity of the water were it measured at 25C.
Emission	Pollution discharged into the atmosphere from smokestacks, other vents, and surface areas of commercial or industrial facilities, from residential chimneys; and from motor vehicle, locomotive, or aircraft exhausts.
Emission factor	The relationship between the amount of pollution produced and the amount of raw material processed.
Emission standard	The maximum amount of air polluting discharge legally allowed from a single source, mobile or stationary.
Endangered (EN)	A species is Endangered when the best available evidence indicates that meets any of the criteria A to E for Endangered, and it is therefore considered to be facing a very high risk of extinction in the wild.
Endangered Species	A species considered to be facing a very high risk of extinction in the wild, assessed using the IUCN Red List Categories and Criteria.
Endemic Bird Area - EBA	One of 218 discrete biogeographic regions holding at least two restricted-range birds, as assessed by Birdlife International.
Endemic species	<p>A species that is restricted to a particular geographic area and thus are found nowhere else on earth. Species that are endemic to small geographic ranges are known as restricted-range species.</p> <p>A species of animal or plant native to, or limited to, a specific geographical area</p>
Environmental awareness and education	Activities designed to inform, disseminate ideas, promote debates, and inspire changes to generate a lasting change of behavior in favor of conservation.
Environment	The total of all those physical, chemical, biological and social economic factors that impinge on an individual, a community or a population

Environmental audit	An analysis of the technical, procedural and decision making aspects of an EIA carried out sometime after a proposal has been implemented.
Environmental Impact	A change in effect on an environmental resource or value resulting from human activities including project development, often called an "effect".
Environmental Impact Assessment (EIA)	A formal process to predict the environmental consequences of human development activities and to plan appropriate measures to eliminate or reduce adverse effects and augment positive effects.
Environmental Management	Management and control of the environment and natural resources systems in such a way so as to ensure the sustainability of development efforts over a long-term basis
Environmental monitoring	Observation of effects of development projects on environmental resources and values
Environmental planning	All planning activities with the objective of preserving or enhancing environmental values or resources
Erosion	Wearing away of rock or soil by the gradual detachment of soil or rock fragments by water, wind, ice, and other mechanical, chemical, or biological forces <i>Feeding on a large variety of food</i>
Euryphagous	
Eutrophication	The slow aging process during which a lake, estuary, or bay evolves into a bog or marsh and eventually disappears.
Evapotranspiration	The loss of water from the soil both by evaporation and by transpiration from the plants growing in the soil.
Exposure	A potential health threat to the living organisms in the environment due to the amount of radiation or pollutant present in the environment.
Fauna	All the animals of an area or a period of time
Fertilizer	Materials such as nitrogen and phosphours that provide nutrients for plants.
Flapship species	These are popular, charismatic species that serve as symbols and rallying points to stimulate conservation awareness and action.
Flood Plain	Area bordering a river which is flooded when the river rises over its normal banks.
Flora	All the plants growing in a particular area

Fluorocarobon (FCs)	Any of a number of organic compounds analogous too hydrocarbons in which one or more hydrogen atoms are replaced by fluorine.
Fly ash	Noncombustible residual particles from the combustion process carried by flue gas.
Food chain	Food chains describe the eating relationships between species within an ecosystem or a particular living place.
Food web	Food webs describe the transfer of energy between species in an ecosystem.
Greenhouse effect	The warming of the Earth's atmosphere caused by a buildup of carbon dioxide or other trace gases; many scientists believe that this buildup allows light from the sun's rays to heat the Earth but prevents a counterbalancing loss of heat.
Gregarious	Gregarious bamboo flowering means simultaneous flowering of bamboos in the whole forests; of animals that travel in herds or packs
Groundwater	Subsurface water and underground streams that can be collected with well, or that flow naturally to the earth's surface though springs.
Habitat	The local environment, in which an organism normally lives and grows.
Habitat diversity	The number of kinds of habitat in a given unit area.
Hatchery:	A hatchery is a facility where eggs are hatched under artificial conditions, especially those of fish or poultry. It may be used for ex-situ conservation purposes, i.e. to breed rare or endangered species under controlled conditions; alternatively, it may be for economic reasons.
Heavy metals	Metallic elements with atomic number greater than 20, such as mercury and lead.
Herbivores	An herbivore is an animal that is adapted to eat plants and not meat.
Hotspot	Terrestrial biodiversity hotspot - Regions that harbor a great diversity of endemic species and have been significantly impacted and altered by human activities.
Hydrocarbons (HC)	Chemical compounds that consist entirely of carbon and hydrogen.

Hydroelectricity/Hydroelectric Power	The production of electric power through use of the gravitational force of falling water.
Hydrogen sulfide (HS)	Gas emitted during organic decomposition and as a by-product of oil refining and burning.
Hydrology	Science that deals with the transportation and distribution of water in the atmosphere, on and beneath the earth's surface.
Hypolimnion	The hypolimnion is the dense, bottom layer of water in a thermally stratified lake. It is the layer that lies below the thermocline.
Impact assessment	A process of predicting and evaluating the effects of an action or series of actions on a defined target. Ideally impact assessment provides a systematic analysis of the enduring or significant changes in a system resulting from a given action or set of activities and then helps to determine if observed changes are positive or negative and intend or not.
Impoundment	A body of water or sludge confined by a dam, dike, floodgate, or other barrier.
Indicator species	The presence or fluctuation of an indicator species is believed (or hoped) to reflect either that of other species in the community or a change in the environment. However, it is uncertain that any species can serve as consistently good indicator. In addition, when using indicator species, it is important to note that specific conservation action targeted at an indicator species is likely to change its indicator ability.
Indirect discharge	Introduction of pollutants from a nonresidential source into a publicly owned waste treatment system.
Infiltration	The penetration of water through the ground surface into subsurface soil or the penetration of water from the soil into sewer or other pipes through defective joints, connections, or manhole walls.
Inorganic chemicals	Chemical substances of mineral origin, not of basically carbon structure.
Insecticide	A pesticide compound specifically used to kill or control the growth of insects.
Inundate	To flood; overflow
Irrigation	Technique for applying water or wastewater to land areas to supply the water and nutrient needs of plants.

IUCN Red List of Threatened Species	A system containing taxonomic, conservation status, and distribution information on taxa that have been valuated using the IUCN Red List Categories and Criteria, which is designed to determin the relative risk of global extinction, and which aims to catalogue and highlight those taxa that are facing a higher risk global extinction.
Key biodiversity area	An area comprising critical habitat for the survival of globally threatened and geographically concentrated species, that can be managed for conservation.
Keystone species	These are species whose impacts on their community are greater than expected from their relative abundance. A subset of these are engineer species, which actually modify their ecosystem. While conservation of these species, will be very important for achieving corridor-scale conservaion outcomes, they are not necessarily targets for species -scale conservation in themselves.
kilowatt (kW)	The electrical unit of power, which equals 1,000 watts or 1.341 horsepower
kilowatt-hour (kWh)	A basic unit of electrical energy that equals one kilowatt of power applied for one hour.
Lacustrine	Lacustrine means "of a lake" or "relating to a lake".
Landslide	A movement of earth and rocks down a steep slope
Leaching	The process by which soluble constituents are dissolved and carried down through the soil by a perfolating fluid.
Least Concerned Species	<p>A species is Least Concerned when it has been evaluated against the criteria and does not qualify for Critically Endangered, Endangered, Vulnerable or Near Threatened. Widespread and abundant species are included in this category.</p> <p>Standing water. Lentic refers to standing or still water.</p>
Lentic	Lentic ecosystems are the ecosystems of lakes, ponds and swamps.
Lentic ecosystem	Running water. Lotic refers to flowing water.
Lotic	Lotic ecosystems are the ecosystems of rivers, streams and springs.
Lotic ecosystem	A macrophyte is an aquatic plant that grows in or near water and is either emergent, submergent, or floating. In lakes macrophytes provide cover for fish and substrate for aquatic invertebrates, produce oxygen, and act as food for some fish and wildlife.
Macrophyte	

Megawatts (MW)	A megawatt is one million watts or one thousand kilowatts, a measure of electrical power or generation capacity.
Methane	A colorless, nonpoisonous, flammable gas created by anaerobic decomposition of organic compounds.
mg/l	A milligram per litre is a measurement of concentration used to measure how many milligrams of a certain substance are present in one litre of liquid.
Microbes	Microscopic organisms such as algae, viruses, bacteria, fungi, and protozoa, some of which cause disease.
Mitigation	The act of alleviating or making less severe
Millenium Development Goals (MDGs)	Have targeted the integration of environmental and sustainable development considerations into country policies and programs and the reversal of the integration of the loss of environmental resources.
Mitigating measures	Modifications of actions that (1) avoid impacts by not taking a certain action or parts of an action; (2) minimize impacts by limiting the degree or magnitude of the action and its implementation; (3) rectify impacts by repairing, rehabilitating, or restoring the affected environment; (4) reduce or eliminate impacts over time by preservation and maintenance operations during the life of the action; or (5) compensate for impacts by replacing or providing substitute resources or environments.
Monitoring	Periodic or continuous surveillance or testing to determine the level of compliance with statutory requirements or pollutant levels in various media or in humans, animals, and other living things.
Nitrate	A compound containing nitrogen that can exist in the atmosphere or as a dissolved gas in water and can have harmful effects on humans and animals.
Nitric oxide (NO)	A gas formed by combustion under high temperature and high pressure in an internal combustion engine.
Nitrogen dioxide (NO₂)	The result of nitric oxide combining with oxygen in the atmosphere; a major component of photochemical smog.
Nitrogenous wastes	Animal or vegetable residues that contain significant amounts of nitrogen.
Non-Governmental Organization	Private organizations that pursue activities to relieve suffering, promote the interests of the poor, protect the environment, or undertake community development, (World Bank Operational Directive 10.70)

Nonpoint sources	Pollution sources that are diffuse and do not introduced into a receiving stream from a specific outlet.
Near Threatened Species	A species is Least Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualify for a threatened category in the near future.
Nutrient	Any substance assimilated by living things that promotes growth.
Oak	Any fagacedus tree or shrub of the genus Quercus bearing the acorn as fruit
Oceanodromous	Oceanodromous fish migrate within salt water only
Omnivores	An omnivore is an animal that is adapted to eat both plants and animals as their primary food source.
Organic	Referring to or derived from living organisms.
Organic chemicals/compounds	Animal- or plant- produced substances containing mainly carbon, hydrogen, and oxygen.
Organophosphates	Pesticide chemicals that contain phosphorus; used to control insects.
Oxidation	1) The addition of oxygen, which breaks down organic waste or chemicals such as cyanides, phenols, and organic sulfur compounds in sewage by bacterial and chemical means. 2) Oxygen combining with other elements. 3) The process in chemistry whereby electrons are removed from a molecule.
Oxydative Redox Potential (ORP)	Reduction potential (also known as redox potential, oxidation/reduction potential or ORP) is the tendency of a chemical species to acquire electrons and thereby be rediced. Each species has its own intrinsic reduction potential; the more positive the potential, the greater the species' affinity for electrons and tendency to be reduced. In aqueous solutions, the reduction potential is the tendency of the solution to either gain or llose electrons when it is subject to change by introduction of a new species. A solution with a higher (more positive) reduction potential than the new species will have a tendency to gain electrons from the new species (i.e. to be reduced by oxidizing the new species) and a solution with a lower (more negative) rediction potentia will have a tendency to o9se electrons to the new species (i.e. to be oxidized by reducing the new species). Just as the transfer of hydrogen ions between chemical species determines the reduction potential of an aqueous solution. Like pH, the reduction potential represents an intensity factor.

Ozone (O₃)	Found in two layers of the atmosphere, the troposphere and the stratosphere. In the troposphere (the layer extending 7 to 10 miles up from the Earth's surface), ozone is a chemical oxidant and major component of photochemical smog. In the stratosphere (the atmospheric layer beginning 7 to 10 miles above the Earth's surface), ozone is a form of oxygen found naturally that provides a protective layer shielding the Earth from the harmful health effects of ultraviolet radiation on humans and the environment.
Ozone depletion	Destruction of the stratospheric ozone layer that shields the Earth from ultraviolet radiation harmful to biological life.
Parastatal	A government owned company
Particulates	Fine liquid or solid particles, such as dust, smoke, mist, fumes, or smog, found in air or emissions.
Pathogen Pathogenic	An organism or substance which causes disease Capable of causing disease.
Periphyton	Periphyton is a complex mixture of algae, cyanobacteria, heterotrophic microbes, and detritus that is attached to submerged surfaces in most aquatic ecosystems. It serves as an important food source for invertebrates, tadpoles, and some fish.
Permeability	The rate at which liquids pass through soil or other materials in a specified direction.
Pesticide	Substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest.
Phenols	Organic compounds that are by-products of petroleum refining, tanning, and textile, dye, and resin manufacturing.
Phosphates	Certain chemical compounds containing phosphorus.
Phosphorus	An essential chemical food element that can contribute to the eutrophication of lakes and other water bodies.
Photosynthesis	The manufacture of carbohydrates and oxygen by plants from carbon dioxide and water in the presence of chlorophyll, using sunlight as an energy source.
Phytobenthos	The flora of the sea bottom or the bottom of inland waters. Phytobenthos are plants belonging to the benthos.
Phytoplankton	Wandering plants in the water. Phytoplankton are the autotrophic component of the plankton community.

pH	pH is a measure of the acidity or basicity of a solution. It is defined as the cologarithm of the activity of dissolved hydrogen ions (H^j). Hydrogen ion activity coefficients cannot be measured experimentally, so they are based on theoretical calculations. The pH scale is not an absolute scale; it is relative to a set of standard solutions whose pH is established by international agreement.
Plankton	The usually small marine or freshwater plants (phytoplankton) and animals (zooplankton) drifting with the surrounding water, including animals with weak locomotory power. Plankton consists of any drifting organisms (animals, plants, archaea, or bacteria) that inhabit the pelagic zone of oceans, seas, or bodies of fresh water.
Plantivore	A plantivore is an animal that is adapted to eat plankton.
Point source	A stationary location or fixed facility from which pollutants are discharged or emitted; any single identifiable source of pollution, e.g., a pipe, ditch, ship, ore pit, or factory smokestack.
Potable water	Water that is safe for drinking and cooking.
Potamodromous	Potamodromous fish migrate within freshwater only.
Powerhouse	A primary part of a hydroelectric dam where the turbines and generators are housed and where power is produced by falling water rotating turbine blades.
Ppm/ppb	Parts per million/ parts per billion, a way of expressing tiny concentrations of pollutants in air, water, soil, human tissue, and food and or other products.
Precipitation	Removal of solids from liquid waste so that the hazardous solid portion can be disposed of safely; removal of particles from airborne emissions.
Preliminary EIA	A preliminary attempt to evaluate environmental impacts in order to determine whether a full-scale environmental impact assessment is needed.
Prevention	Measures taken to minimize the release of wastes to the environment.
Primary wastewater treatment	First steps in wastewater treatment; screens and sedimentation tanks are used to remove most materials that float or will settle.
Rapid Assessment Program	A biological inventory program that assembles teams of scientists to produce rapid assessments of the biological value of poorly known areas that are potentially important biodiversity conservation sites, and thus catalyxe conservation action.

Raw sewage	Untreated wastewater
Residual	Amount of a pollutant remaining in the environment after a natural or technological process has taken place, e.g., the sludge remaining after initial wastewater treatment, or particulates remaining in air after the air passes through a scrubbing or other pollutant removal process.
Reservoir	A body of water collected and stored in an artificial lake behind a dam.
Resettlement	The act of moving people and their animals to a new area of habitation.
River Basin	The area covered by the river, including its many tributaries, from its source to the sea.
Riverine	Situated on a river or river bank.
Runoff	That part of precipitation, snowmelt, or irrigation water that runs off the land into streams or other surfact water; can carry pollutants from the air and land into the receiving waters.
Salty	An adjective describing something with the properties, usually taste, of salt
Sedimentation	Letting solids settle out of waste water by gravity during wastewater treatment.
Sediments	Soil, sand, and minerals washed from land into water, usually after rain.
Sewage	The waste and wastewater produced by residential and commercial establishments and discharged into sewers.
Sewage sludge	Sludge produced at a municipal treatment works.
Scoping	An exercise involving the preliminary identification of the environmental issues surrounding a project that requires an assessment. Scoping identifies the potential impacts which are to be addressed in detail by the assessment. Scoping will usually initiate the public consultation/public participation process.
Screening	Screening is the process of determining whether or not an individual project proposal requires a full-scale EIA and what the level of assessment should be.
Sediment	Material deposited by water, wind or glaciers.

Shower	A brief and usually light fall of rain or snow.
Silt	Fine particles of sand or rock that can be picked up by the air or water and deposited as sediment.
Sludge	A semisolid residue from any of a number of air or water treatment processes. Sludge can be hazardous waste.
Smog	Fog made heavier and darker by smoke.
Smoke	Particles suspended in air after incomplete combustion of materials.
Solid wastes	Nonliquid, nonsoluble materials, ranging from municipal garbage to industrial wastes, that contain complex, and sometimes hazardous, substances.
Species	A group of organisms capable of interbreeding and producing fertile offspring of both genders, and separated from other such groups with which interbreeding does not (normally) happen.
Species area curve	The number of species in relation to change in area of habitat.
Species diversity	Used to mean the variety of species in an area or on the earth; technically it is composed of three components: species richness, species evenness and species dominance.
Species dominance	The most abundant species in a particular area or in a community.
Species evenness	The relative abundance of species in a particular area or in a community.
Species heterogeneity	Measurement of relative abundance of species.
Species richness	The total number of species in a particular area. It is the total number of different species in a particular area or in a community
Stack	A chimney or smokestack; a vertical pipe that discharges used air.
Stenophagous	Feeding on a limited variety of food
Sulfur dioxide (SO₂)	A heavy, pungent, colorless, gaseous air pollutant formed primarily by processes involving fossil fuel combustion.
Surface water	All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.); also refers to springs, wells, or other collectors that are directly influenced by surface water.

Suspended solids	Small particles of solid pollutants that float on the surface of or are suspended in sewage or other liquids.
Thermal pollution	Discharge of heated water from industrial process that can affect the life processes of aquatic organisms.
Total dissolved solids (TDS)	Total Dissolved Solids (often abbreviated TDS) is an expression for the combined content of all inorganic and organic substances contained in a liquid which are present in a molecular, ionized or micro-granular (colloidal sol) suspended form. Generally the operational definition is that the solids must be small enough to survive filtration through a sieve size of two micrometres. Total dissolved solids are normally only discussed for freshwater systems, since salinity comprises some of the ions constituting the definition of TDS. The principal application of TDS is in the study of water quality for streams, rivers and lakes, although TDS is generally considered not as a primary pollutant (e.g. it is not deemed to be associated with health effects), but it is rather used as an indication of aesthetic characteristics of drinking water and as an aggregate indicator of presence of a broad array of chemical contaminants.
Total nitrogen	Total Kjeldahl Nitrogen (TKN) is the sum of organic nitrogen; ammonia (NH ₃) and ammonium (NH ₄ ⁺) in the chemical analysis of soil, water, or wastewater (e.g. sewage treatment plant effluent). To calculate Total Nitrogen (TN), the concentrations of nitrate-N and nitrite-N are determined and added to TKN.
Total Suspended Solids (TSS)	A measure of the suspended solids in wastewater, effluent, or water bodies.
Toxic pollutants	Materials contaminating the environment that cause death, disease, or birth defects in organisms that ingest or absorb them.
Toxic substance	A chemical or mixture that may present an unreasonable risk of injury to health or the environment.
Toxicity	The degree of danger posed by a substance to animal or plant life.
Transparency	Transparency is the physical property of allowing light to pass through a material.
Turbidity	Turbidity is the cloudiness or haziness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality.

Umbrella species	These have large home ranges but specific habitat requirements, such that their conservation is often assumed to save many other species automatically. However, the empirical evidence for this is scanty at best.
Upstream	Toward or in the higher part of the stream or the river
Urban runoff	Stormwater from city streets and adjacent domestic or commercial properties that may carry pollutants of various kinds into sewer systems or receiving waters.
uS/cm	Micro siemens Per Centimeter. Unit for electrical conductivity
Vector	An organism which carries or transmits a pathogen
Vegetation	All different types of plants that are found in a particular area or environment.
Vulnerable Species	<p>A species is Vulnerable when the best available evidence indicates that it meets any of the criteria A to E for Vulnerable and it is therefore considered to be facing a high risk of extinction in the wild.</p> <p>A vulnerable species is a species which is likely to become endangered unless the circumstances threatening its survival and reproduction improve.</p>
Wastes	Unwanted materials left over from a manufacturing process. 2) Refuse from places of human or animal habitation.
Wastewater treatment plant	A facility containing a series of tanks, screens, filters, and other processes by which pollutants are removed from water.
Wasterwater	Spent or used water from individual homes, communities, farms, or industries that contains dissolved or suspended matter.
Water pollution	The presence in water of enough harmful or objectionable material to damage water quality.
Water quality criteria	Specific levels of water quality that, if reached, are expected to render a body of water suitable for its designated use. The criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, fish production, or industrial processes.
Watershed	A region or an area over which water flows into a particular lake, reservoir, stream, or river. (OR) the region or area of land that forms the drainage of a stream or river. If a drop of rain falls anywhere within a watershed to become surface runoff, it can flow out only through the same stream or river.

Watershed Management	The analysis, protection, development, operation or maintenance of the land, vegetation and water resources of a drainage basin for the conservation of all its resources for the benefit of its residents.
Water quality	A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.
Wetlands	Land (marshes or swamps) saturated with water constantly or recurrently.
Zoobenthos	The fauna of the sea bottom or the bottom of inland waters. Zoobenthos are animals belonging to the benthos.
Zooplankton	Wandering animals in the water. Zooplankton are the heterotrophic (sometimes detritivorous) type of plankton. Zooplankton are the heterotrophic (sometimes detritivorous) type of plankton. Zooplankton are organisms drifting in the water column of oceans, seas, and bodies of fresh water.

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Biodiversity And Nature Conservation Association (BANCA)

Yangon, Myanmar.

October 2009.

EXECUTIVE SUMMARY

Regarding the big scale hydropower development in Ayeyawady basin, above Myitkyina, the main audience for this document are the people of Myanmar, in particular conservationists, developers, and highest decision-makers at political and administrative levels of our country. Before making their decisions they must be well informed, convinced and enlightened about the importance of environmental and biodiversity conservation in sustainable development of Myanmar. The other aimed audience for this document are Myanmar Ministry (1) of Electrical Power, China Power Investment Corporation (CPI) and the Chinese scientific institution, Changjiang Institute of Survey, Planning, Design & Research (CISPDR) and concerned donor agencies, enabling them to provide outside assistance and cooperation for sustainable development in Myanmar.

Myanmar is rich in natural resources particularly forests, land and water resources in addition to biodiversity. Achieving sustainable development of these resources is vital to the country. Unplanned and environmentally naïve economic forces are driving the over-exploitation of Myanmar's forests, water resources, wetlands and coastal ecosystems. This accelerating degradation of natural resources increasingly threatens the country's prospects for long term sustainable development and is already limiting its future options. Reform of the political, legal, institutional and economic structures of the country is needed to ensure successful implementation of sustainable development of the country. One of the pre-requisites is to enact and enforce the drafted national environmental protection law without delay and make credible environmental impact assessments (EIAs) mandatory, prior major development programmes and projects.

Although EIA is not mandatory yet in Myanmar, **PART I** clearly justifies that EIA is not a hindrance to development of the country but ensures sustainable development. In relation to the big scale hydropower development in Ayeyawady basin, above Myitkyina, Part I provides an overall view on Union of Myanmar and its people, importance of Ayeyawady River, and it looks at Kachin State and its outstanding biophysical features. It also highlights the importance of EIA introduction to Myanmar, importance of BIA and terms of reference between BANCA and CISPDR. Part I also examines Myanmar's national environment policy, associated international environmental conventions and relevant national resource management laws. It also explores and vividly describes biodiversity richness in northern Myanmar. Part I also predict potential impacts on biodiversity on account of dam construction and urges immediate compensatory measures with prioritized actions to counter adverse impacts. It predicts potential impacts on aquatic ecology & fisheries and water quality and recommends prioritized actions to counter impacts. The potential impacts on livelihoods, public health & safety are predicted and prioritized actions to counter impacts are urged. It also examines trans-boundary wildlife and timber trade and recommends prioritized actions to lesson illegal trade of wildlife and forest products. Part I also describes about the background of hydropower development in Kachin State and explains about series of dams namely, Myitsone, Lasa, Chebwe, Yenam, Kaunglanphu, Wusot and Pisa. It summarizes overall recommendations and mitigating measures from policy perspective, environmental perspective, social perspective and administrative & technical perspective.

In concluding Part I, lack of social impact assessment in this study has been emphasized. And the need of systematic social impact assessment by competent social scientists has been recommended. Before approving the construction of a series of dams on Ayeyawady River above Myitkyina, Kachin State, the decision-makers are strongly urged to fairly balance between negative and positive aspects of dams (App. 2). The decision makers, developers, concerned engineers and dam designers are seriously advised to pay due consideration on the

differences between bad and good dams and between environmental threatening and environmental friendly dams (App. 3). The core construction engineers are also strongly urged to pay serious attention on the appended suggestions towards dam construction (App. 1).

PART II aims at specialists and experts of diverse disciplines and describes in detail of various fields of study at proposed dam sites. It provides in detail, the fauna report, the flora report and the aquatic report.

Fauna Report begins with introduction and explains about study areas and materials and methods and results. Detail study areas namely, Myitsone study area, Lasa study area, Chibwe study area, Wusok & Pisa study areas, Khaunglanphu study area and Yenam study area are described. This is followed by discussions on the results of mammals, amphibians and reptiles, and insects in each study area. Aiming at ornithologists, a separate ornithological report has been prepared and attached. Threatened faunal species and their conservation status have been explained along with overall conclusions and discussions.

Fauna Report also comprises a separate Faunal Ecological Report.

Flora Report covers Myitsone study area, Lasa study area, Chibwe study area, Khaunglanphu study area, Yenam study area and Wusok & Pisa study areas.

For each study area, the flora report begins with introduction, aims and objectives. It explains about materials and methods and analyses results. This is followed by discussion and conclusion together with recommendations. Flora Report also comprises a separate Floral Ecological Report.

PART III adds in detail, on Aquatic Report, Environmental Baseline Study Report and Wildlife Trade Report.

Aquatic Report describes and discusses on aquatic ecological conditions, aquatic organisms and fish species in Mayhka, Malihka and Ayeyawady River. Temperature and dissolved oxygen concentrations were measured and recorded. Zooplankton, Periphyton, Benthos and Phytoplankton species composition, economically important fish genera and endangered fish species were also examined and recorded.

Environmental Baseline Study Report points out the baseline study as a prerequisite before dam constructions and describes about monitoring of surface water at low flow and high flow at 18 river stations of proposed dam sites and key tributaries of the river system. This study has been on pH, BOD, COD, water temperature, total suspended solids, nitrogen, phosphorus, phenol, cyanide, oil and grease, arsenic, chromium, mercury and zinc. As the local scientists have done their best within limited time along with some constraints, internationally well experienced expertise is needed to guide their study as this hydropower project would be a huge and sensitive one.

Wildlife Trade Report examines both forest products and wildlife products and briefs about illegal logging and wildlife trade in Kachin State. Traded wildlife species, their traded parts along with prices are described. The report looks at in-country market surveys including Myanmar-China border markets, questionnaire surveys on livelihoods in relation to wildlife species, bush meat consumption, and wildlife and plant parts used in traditional medicines. It concludes with some recommendations after exploring the eight major trade routes of wildlife trade in Kachin State which are the current source of origin of international trade via China.

ENVIRONMENTAL IMPACT ASSESSMENT (SPECIAL INVESTIGATION) ON HYDROPOWER DEVELOPMENT OF AYEYAWADY RIVER ABOVE MYITKYINA, KACHIN STATE, MYANMAR

1. INTRODUCTION

1.1. Union of Myanmar and its People

Myanmar is the largest country on mainland Southeast Asia. It has a total land area of 677,000 square kilometers, and shares borders with five countries for about 6,151 kilometers sharing 274 kilometers with Bangladesh on the West, 1,339 kilometers with India on the North-West, 2,205 kilometers with China on the North-East, 225 kilometers with Laos on the East and 2108 kilometers with Thailand on the South-East. It has a total coastline of 2,229 kilometers (NCEA 2009).

Myanmar lies on the crossroads of two of the world's great civilization and densely populated countries, China and India. The population of Myanmar in the fiscal year 2005/06 is estimated at 55.4 million. Myanmar is a union of many nationalities speaking over one hundred languages and dialects, but living in close harmony.

Myanmar has three parallel chains of forest-clad mountain ranges that run north to south from the eastern extremity of the Himalayan mountain range, the Western Yoma or Rakhine Yoma, the Bago Yoma and the Shan Plateau. These three mountain chains divide the country into three river systems, the Ayeyawady, the most important river in the country, the Sittaung and the Thanlwin. Union of Myanmar has been made up of 7 States, namely Kachin, Shan, Kaya, Rakhine, Kayin, Mon, and Chin and 7 Divisions, namely, Ayeyawady, Bago, Tanintharyi, Yangon, Mandalay, Sagaing and Magwe.

1.2. Ayeyawady River

Ayeyawady River is the most important lifeblood river in Myanmar. It runs the whole length of the country through Kachin State, Sagaing Division, Mandalay Division, Magwe Division, Bago Division and Ayeyawady Division before entering into Bay of Bangal. Millions of people are depending on Ayeyawdy River for their livelihoods. Many towns, cities and village tracts are situated along left and right banks of Ayeyawady River. Also it is the most useful water way or navigation in Myanmar for transportation of people, various kinds of goods, timber rafts, etc. by using various sizes of ships, and boats. The Malihka and the Mayhka rivers merge in Kachin State to become the Ayeyawady, largely a glacier-fed river, stretches over a thousand miles long and it is one of the finest water ways in the world. This fertile valley flows through the dry zone in the heart of Myanmar and acts as a conduit of communication to over fifty million people. The hydropower development in Kachin State by constructing a series of large and medium dams may definitely impact on the people of Myanmar as a whole, in addition to adverse impacts on riverine, aquatic, terrestrial and wetlands ecosystems. Therefore the conceptual framework for the development of hydropower development in Kachin State must be based on river basin approach, that is, to consider the impacts starting from the water source origin in Kachin State, downwards along the length of Myanmar, to the mouth of Ayeyawady River at Bay of Bangal.

Ayeyawady is the biggest one among the five rivers of Burma. The catchment area of the river is 49000 km². It originates at snow covered mountainous ranges which have linkage to the Himalaya, at the height of 5789 metre above sea level at North Latitude 28 Degree. Roughly, it goes southward from north to Bay of Bengal along 2092 kilometers. The confluence of Mayhka and Malihka is 48 kilometers up from Myitkyina.

According to morphological characteristics of it, it can be divided into three portions.

- (1) Reception Basin: its origin at Myitsone above Myitkyina to its junction with Chindwin river;
- (2) Central Valley: Ayeyawady-Chindwin Junction to Seiktha Village; and
- (3) The Delta: Seiktha village to outlet into Bay of Bengal.

The Ayeyawady Basin: Particularly the reception basin has many sites with high rainfalls and increased water volume, to produce hydropower generation; the delta, the lower part consists of a large agricultural lands; and middle part has an equilibrium of current flow volume seasonally; and these can be integrated as considerable factors.

On performing dam projects, the following typical characteristics of the Ayeyawady should be inclusive of due consideration (MOAI 2002):

- (1) Most of the water catchments areas of Ayeyawady are situated at Reception Basin. There are a lot of deep forests and mountainous ranges with full of small streams and rapids. Water drains directly from high rain fall and melting of the snow, accounts 84 percent of current volume.
- (2) Un-equilibrium of distribution of monthly current volume during the rainy season will cause extraordinary flood (flashflood) at juncture of Ayeyawady and Chindwin rivers when there are coincidentally high level of water at these two rivers.
- (3) A lot of rivers and small rivers, which possess large catchments areas of receiving water, have their orifices into Ayeyawady at Reception Basin as rivulets.
- (4) Frequent drought appears at central valley of Ayeyawady.
- (5) At dry season, some points of the middle part have shallow water, hindering the use of inland water transportation.
- (6) During rainy season, imbalance of seasonal current volume will cause flooded areas, and danger of floods appears eminently at the lower part of Ayeyawady.
- (7) During dry season, sea water intrudes into the lower part of delta together with high tidal water volume, due to low volume of water current from upper parts.
- (8) Many sand-beds and islands appear at the outlet to sea and these conditions lead to high level of basin of river gradually at lower part of delta. Thus the interval of frequency of floods becomes short and high and as a consequence the orifices become closed.
- (9) Continuous impact of rivers such as changing pattern of current water, sand beds, landslides due to rapid water force, are still appearing.

Generally, dams can play an important role in meeting people's needs. However in making large dams on Ayeyawady, Mayhka and Malihka rivers, the welfare of the people to be displaced must be brought into due consideration. The last 50 years have highlighted the performance and the social and environmental impacts of large dams. The developers have fragmented and transformed the world's rivers, while global estimates suggest that 40-80 million people have been displaced by reservoirs (WCD 2000). The fragmentation of Ayeyawady River by a series of dams will have very serious social and environmental problems not only at upstream of dams but also to very far downstream till to the coastal delta. A longer and comprehensive EIA investigation is strongly recommended in such a very big and sensitive hydropower development which may have very significant adverse impacts.

1.3. Kachin State

It is the northernmost state in the union of Myanmar which is very rich in hydropower resources. The area of Kachin State is 89,041 km² (34,379 sq mi). Official government statistics state that the distribution by religion is 57.8% [Buddhist](#), 36.4% [Christian](#) and the rest, animism.

1.3.1. Cities and Towns:- Myitkyina, a major city in the central area, is the state capital, while Bamaw is the main town in the southwest, and Putao the main town in the far north. Mogaung and Mohnyin are ancient cities inhabited mostly by Shans. Myitkyina is well known as one of the places in Myanmar where the allied forces of the west, led by General Merrill's Marauders, landed and fought the enemy together with local rangers.

1.3.2. Communication:- The 18 townships in the states are linked by roads, railways, and airways. Most of the towns in the state are accessible by telephone communication, locally and internationally. The state's major towns are linked with other capital cities of Myanmar by road, railways, waterways, and airways. The State is linked to India by Ledo Road, also known as the Stilwell Road, built during World War II.

1.3.3. Geography:- Kachin State is part of the eastern edge of the Himalayan Range and is also continuous with the Yunnan escarpment, composing the Tibet-Myanmar frontier mountain ranges. Hkakaborazi, the highest mountain in South East Asia at 19 315 feet, and Indawgyi, the largest lake in Myanmar with 98 square miles, are all located in Kachin State. Kachin state is dominated by high mountainous with large valleys. The highest mountains in Myanmar and Southeast Asia are there the highest being Mt Hkakaborazi which is 5881 meters (19290 ft) high.

Its borders are Yunnan Province of China in the east, Shan State and Sagaing division in the south and southwest, Arunachal Pradesh and Assam province of India in the west and Xizang Autonomous region (Tibet) of China in the north.

Mainly has 4 valleys. Putao valley, Myitkyina valley, Moekaung valley and Hukaung Valley. Here lies the origin of the Irrawaddy river. Myanmar people considered this river a total Myanmar river meaning that it originates and ends in Myanmar. But if the origin of a river is considered the furthest point from the main uppermost confluence then the origin can be considered to be originated from China. i.e Taron river.

Kachin State is located in the northern most part, is one of the seven States of the Union of Myanmar. Lies between China to the east and India to the west, and has a land area of 34,379.22 square miles.

1.3.4. Districts, Townships and Villages

The four districts constituted in the Kachin State are Myitkyina, Bhamo, Moeahnyin and Putao. The number of townships and wards and village tracts constituted are 18 townships, 9 sub townships respectively.

1.3.5. Townships

(1) Myitkyina District

<u>Township</u>	<u>Sub township</u>
• Myitkyina	Sinbo
• Winemaw	Sadone
• Tanai	Shinbweyan
• Chibwe	

(2) Putao District

- Putao
- Naungmon Pannandin
- Machanbaw
- Khaunglanhpu
- Sumprabum

(3) Bhamaw District

- Bhamaw Lwehre , Dawt -phone-yan
- Moemauk
- Mansi
- Shweku Myohla

(4) Moehnyin District

- Moehnyin Hopin
- Moekaung Kamaing
- Hpakant

1.3.6. Outstanding Biophysical Features

a. Snow Capped Mountains: - In the foothills of the Himalayas in northern Putao situate Mt. Hkakaborazi, the highest snow-capped mountain in South East Asia. 19,269 feet (5881 meter) high and a very important watershed area for the eastern Ayeyawady river (Mayhka). The flagship trek of the area lies more than 440 kilometer away from nearest airstrip which takes nearly 6 weeks to complete. The route passes through the 1472-square-mile Hkakaborazi National Park. Apart from this there are several smaller peaks such as Mt. Lancrumadin of 3495 meters. Mt. Phongun Razi of 3485 meters, Mt. Phangran Razi of 4450 meters, Mt. Madwe Razi of 4500 meters and Mt. Slimatdin of 4800 meters etc which can be scaled by trekker with normal physical condition.

b. Flora: - More the 50% of Kachin State is generally covered by numerous types of forests with thousands of different plant species. Rhododendron is indigenous to Putao region and of the 600 known species of rhododendria, the English botanist collected 118 here in some 1920s, and some 107 of those may be still viewed at Royal Botanical Gardens in Edinburgh. Also the wild orchids bloom in great profusion in this region. Botanists also identified 19 species of pine with the expeditions. Over 800 kinds of orchids, 97 varieties of bamboo and 32 different types of rattan canes are also home to this region. The forests ranging from tropical monsoon evergreen to alpine forest can also be found in the northern most part of the state. The rich variety of plants and animal life in Kachin State reflects its geographical location as well as its varied topography and climate.

c. Fauna: - As many as 400 avian species were also recorded so far. Among them 15 rare species of Pheasant among them being a few on the endangered list, the Impeyan Pheasant, the Blood Pheasant. Blyth's Tragopan, Temminck's Tragopan, Sclater's Monal, Snowy-throated Babbler, Chestnut thrush, Red-tailed Laughing trush and Rusty bellied Short wing etc to name a few in the rare species list and some new identified species in Myanmar and South-East Asia. The area is home to numerous wild animals-including monkeys, deer, birds and butterflies - so it is no wonder paradise for scientific researchers and butterfly hunters. There is a safe habitat for wild elephants, tigers, takins, rare red pandas and other endangered species. Migratory birds from China and Mongolia, travel in thousands to the plateau of Putao in spring, and disperse in early monsoon.

1.3.7. Climate & Rainfall

Regarding climatic conditions, it is generally divided into three seasons: the hot summer, the rainy monsoon and the cold winter. Climatic conditions vary considerably from warm to humid in the lowlands and extremely cold in the highlands. In winter, mountains in the far north are snow capped. The rainy season starts in May in the lowlands and April in the highlands. The winter starts in December followed by a very short summer.

Regarding rainfall, and reference to rainfall isohyets for Myanmar the Kachin state receives 80 - 150 inches of rain annually increasing as it goes north. The northernmost Putao district receives more than 150 inches of rain.

1.3.8. Access & Transportation

The capital of Kachin State is Myitkyina. It can be approached by all means of transportation, i.e car, railway, boat and air. Approaching by car, the roads system is in poor state. Mandalay to Myitkyina (779 km) is not recommended for tourists and foreigners. The capital of Kachin state Myitkyina can be approached via Shwebo - Myitkyina strategic road. Although this road was constructed as an all weather road now it is safe only to drive in the dry season. It is about 500 kilometers from Mandalay. Due to poor maintenance the road is very tough and takes two full days to drive from Mandalay.

Another approach is from Tha-Beik-kyin, Tagaung, Bhamaw road. This road goes along the eastern bank of Ayeyawady river. The length is almost the same but only a porter is better than the former road and the driving time is slightly shorter than the former one.

The railway from Mandalay was built since the Second World War. There are four trains from Mandalay to Myitkyina daily. The fastest train takes approximately 16 hours to reach Myitkyina. There are daily trains between Mandalay and Myitkyina which take somewhere between 24 and 30 hours to reach each destination.

Myitkyina can be also reachable from Mandalay by boat. The Ayeyarwady river is navigable from Mandalay to Bhamaw. But above Bhamaw, there are narrow sections and rapids and only small and powerful boats usually go along that part.

There are two airlines that regularly fly from Yangon to Myitkyina. The government owned Myanmar Airways flies 4 flights a week from Yangon. The flights are not regular. The private airline Air Bagan flies 3 flights a week.

1.3.9. Ethnic Minorities

There are 11 ethnic tribes in Kachin State. Jinghpaw, Law Wor (Maru), Lacheik, Rawan (Khanoung), Khamti Shan and Lesu. Kachin comprises of eleven ethnic minorities, namely Jinghpaw, Lachik, Dalaung, Lauwaw, Guari, Lisu, Rawang, Hkahku, Duleng, Atsi and Zaiwa. There are also other nationalities such as Shan, Bamar, Kadu, Kanan, Chinese and Indians living in the Kachin State.

1.3.10. Livelihoods & Festivals

As for grassroots people, agriculture is the main occupation with rice as the main crop. Kachin State is a place where grapefruit and other rare citrus fruits are available. Pineapple, starapple, djenkol bean (da-nyin in Myanmar) fruit and a kind of rice (hkatchyo rice in Myanmar) are among the best quality in the Myanmar market.

Kachin State celebrates Kachin State day on the 10th of January, and the New Harvest Festival in November. There are many locally celebrated festivals among the people. One of the common festivals among the Kachin people is the Manau.

1.3.11. Mineral Resources

Kachin State is rich in forest products, minerals, and gem stones some of which are still untouched. Phakant jade is one of the most famous products of the state and is very popular in the world. Gold can be panned in almost every river and stream of the state.

2. IMPORTANCE OF EIA INTRODUCTION

Economic, social and environmental change is inherent to development. Whilst development aims to bring about positive change it can lead to conflicts. In the past, the promotion of economic growth as the motor for increased well-being was the main development thrust with little sensitivity to adverse social or environmental impacts. The need to avoid adverse impacts and to ensure long term benefits led to the concept of sustainability. This has become accepted as an essential feature of development if the aim of increased well-being and greater equity in fulfilling basic needs is to be met for this and future generations.

In order to predict environmental impacts of any development activity and to provide an opportunity to mitigate against negative impacts and enhance positive impacts, the environmental impact assessment (EIA) procedure was developed in the 1970s. An EIA may be commonly defined as: 'a formal process to predict the environmental consequences of human development activities and to plan appropriate measures to eliminate or reduce adverse effects and to augment positive effects'. A different pattern of human behavior will be needed to succeed. It will require shifting from the present reactive mode, when severe problems or crises occur, to a much more proactive orientation in which preventive measures are taken on the basis of careful anticipation and foresight. (Norman et al. 1990.)

EIA is a management tool for planners and decision makers and complements other project studies on engineering and economics. Environmental assessment is now accepted as an essential part of development planning and management. It should become as familiar and important as economic analysis in project evaluation.

The aim of any EIA should be to facilitate sustainable development. Beneficial environmental effects are maximized while adverse effects are ameliorated or avoided

to the greatest extent possible. EIA will help select and design projects, programmes or plans with long term viability and therefore improve cost effectiveness.

Initially EIA was seen by some project promoters as a constraint to development but this view is gradually disappearing. It can, however, be a useful constraint to unsustainable development. It is now well understood that environment and development are complementary and interdependent and EIA is a technique for ensuring that the two are mutually reinforcing.

Sustainable development describes it as 'development that meets the needs of the present without compromising the ability of future generations to meet their needs and aspirations' (WCED 1987).

EIA is "a process having the ultimate objective of providing decision-makers with an indication of the likely consequences of their actions" (Wathern 1988).

NEED to dispel the impression that EIA is an obstructive process that keeps people in poverty rather than one that ensures future generations and present generation will enjoy resource security and a good quality of life.

Although detailed steps in the EIA process vary from country to country, there are a number of generic steps which are followed internationally.

Screening is the process of determining whether or not an individual project proposal requires a full-scale EIA and what the level of assessment should be. Most countries have lists of activities for which EIAs are required (e.g. mining or major construction works). In addition, some countries have identified sensitive environments (e.g. cultural heritage sites) for which EIAs are needed.

Scoping determines the nature and extent of the required impact assessment. This phase entails the identification of issues that are likely to be important during the EIA and eliminates those that are not. The objective of this phase is to identify how the activities of the proposed development will impact on the various components of the environment. The impact assessment entails the identification and analysis of impacts, as well as a prediction of the significance of the impacts. Both negative and positive impacts are assessed.

Mitigation entails the identification of ways in which negative impacts can be avoided or minimized to limit costs, and ways in which positive impacts can be enhanced to ensure maximum benefit.

A single EIA report is produced and contains the integrated findings of the impact assessment and mitigation studies. This report shall be used by the authorities in decision-making. In all jurisdictions, the authorities must officially review the EIA report and decide whether it is of an acceptable standard or not.

2.1. China's Concern on EIA

EIA is not mandatory yet in Myanmar. However regarding hydropower development of Ayeyawady River above Myitkyina, we should appreciate China's concern on EIA and should refer their EIA procedure. The PRC's first major environmental statute, the Environmental Protection Law (EPL), was enacted by the State Council in 1979 and revised in 1989. This law brought environmental management within the PRC's legal system and laid the foundation for future environmental legislation (Fuggle et al. 2000). The Environmental Impact Assessment Law (EIA Law) requires an environmental impact assessment to be completed prior to project construction.

The Law of the People's Republic of China on Appraising Environmental Impacts (PRC 2003) has been adopted at the 30th session of the Standing Committee of the Ninth

National People's Congress on October 28, 2002, and is hereby promulgated for effect on September 1, 2003.

Article 1 of the above law has been enacted for the purpose of carrying out the strategy of sustainable development, prevent the unfavorable impacts of programs and constructions projects upon the environment. *Article 2* of the above law refers to the methods and institutions for analyzing, predicting and appraising the impacts of programs and construction projects that might incur after they are carried out so as to propose countermeasures for preventing or mitigating the unfavorable impacts and make follow-up monitoring. *Article 4* refers to provide a scientific basis for decision-making and *Article 5* encourages relevant entities, experts and the general public to participate in the appraisal of the environmental impacts in appropriate ways. *Article 10* refers the environmental impacts of special program including elements: a. An analysis, prediction and appraisal of the environmental impacts that might occur if the program is implemented; b. The countermeasures for predicting or mitigating the unfavorable environmental impacts; c. The conclusion of the appraisal upon the environment. *Article 17* calls for the report of the environmental impacts of a construction project shall include the following elements: a. An introduction of the construction project; b. The surrounding environment of the construction project; c. An analysis, prediction and appraisal of the environmental impacts that may be caused by the construction project; d. The measures for protecting the environment of the construction project as well as a technical and economical demonstration; e. An analysis of the economic gains and losses of the environmental impacts that may be caused by the construction project; f. Suggestions for carrying out environmental monitoring over the construction project; g. Conclusion of appraisal of the environmental impacts.

3. TERMS OF REFERENCE OF EIA BETWEEN CISPDR AND BANCA

Environmental policy without appropriate legislation will be ineffective as, in turn, will be legislation without enforcement. Economic and financial pressures will tend to dominate other concerns. In many developing countries legislation on environmental issues has been in existence for many years. Although EIA is not mandatory as yet in Myanmar, China has been trying it's best to undertake EIA practice before construction of a cascade of dams in Kachin State.

Changjiang Institute of Survey, Planning, Design & Research (CISPDR) of China and Biodiversity and Nature Conservation Association (BANCA), the consultative agency of Myanmar share the responsibility of the environmental impact assessment of hydropower development of Ayeyarwady River Basin above Myitkyina. As the lead unit, CISPDR is in charge of technology and quality of whole environmental assessment of this external entrusted project outside China. Screening is the process of determining whether or not an individual project proposal requires a full-scale EIA and what the level of assessment should be. However BANCA has been just responsible for environmental baseline study and Biological Impact Assessment (BIA) only that excludes social and economic components.

4. IMPORTANCE OF BIOLOGICAL IMPACT ASSESSMENT (BIA)

Biological impact assessment is an integral and important component of environmental impact assessment (EIA). Recent heightened concerns among the people, planners, natural resource managers, and academics across the globe for the biodiversity conservation have provided added impetus to BIA. BIA prepares an inventory of the biological resources that may be at stake once the proposed project is executed and also

provides a broad understanding about the status of other components of the environment that are likely to be impacted. Soil, water and biological communities are interdependent and therefore the BIA provides cue towards health and conservation status of soil and water as well. BIA documents and collates the baseline data and information on the status of biodiversity and bioresources likely to be impacted by the proposed activity and suggests measures for mitigation of the impact. Thus the fundamental objective of the BIA is to conserve the biodiversity and ensure its sustainable utilization. In many countries it is a mandatory requirement before implementation of any major project and it is regulated by national acts and laws.

BIA's objective is to predict loss of genetic resources, habitats, ecosystems etc and to suggest measures to mitigate the impacts of the proposed activity. It is also done on a regular basis during the implementation of the project and at the end of the project period as a part of ecorestoration work. According to Tiwari (2005), the first step of BIA is to collect base line data on plants, animals and microbes found in the area likely to be affected by the activity. There are two major components of data collection for BIA : i) Structural components of the ecosystem which include listing of the variety of species, determining population size, distribution of organisms in trophic levels, identification of keystone species, horizontal and vertical sections of vegetation and habitat and ecosystem diversity including their status with regard to IUCN classification. The other ii) relates to the function of the ecosystems such as rates of primary productivity, respiration, export and import of materials etc. Data on utilization of biological resources and dependency of local people on bioresources are also collected. Based on the BIA study a biodiversity management plan is prepared which outlines the preventive and curative measures for mitigating the impact. The mitigation measures of biological impacts include setting aside or exclusion of critically important areas, compensatory afforestation, creation of green belts, and rehabilitation of species or individuals through active involvement of local community.

5. NATIONAL ENVIRONMENT POLICY OF MYANMAR

To establish sound environment policies in the utilization of water, land, forests, mineral, marine resources and other natural resources in order to conserve the environment and prevent its degradation, the Government of the Union of Myanmar hereby adopts the following policy:-

"The wealth of a nation is its people, its cultural heritage, its environment and its natural resources. The objective of Myanmar's environment policy is aimed at achieving harmony and balance between these through the integration of environmental considerations into the development process to enhance the quality of life of all its citizens. Every nation has the sovereign right to utilize its natural resources in accordance with its environmental policies; but great care must be taken not to exceed its jurisdiction or infringe upon the interests of other nations. It is the responsibility of the State and every citizen to preserve its natural resources in the interest of present and future generations. Environmental protection should always be the primary objective in seeking development".

The policy was proclaimed through the Gazette in accordance with Notification No. 26/94 dated 5 December 1994, of the Government of the Union of Myanmar.

6. INTERNATIONAL ENVIRONMENTAL CONVENTIONS, PROTOCOLS AND AGREEMENTS

International agreements are important because environmental considerations are part of the unified management of our planet (Norman et al. 1990). Myanmar has signed and is party to more than thirty International and Regional Conventions and Protocols. The most relevant environmental conventions are shown in the following Table 1. The protocols and conventions have significant impact in giving direction to local resource management.

Table 1. International and Regional Conventions and Protocols

Title	Date Signed	Date Ratified
Plant Protection Agreement for the South-East Asia and the Pacific Region, Rome, 1956		4-11-1959 (Adherence)
International Convention for the Prevention of Pollution from Ships, London, 1973		(Accession)
Protocol of 1978 Relating to the International Convention for the Prevention of Pollution from Ships, London, 1973		4-8-1988 (Accession)
United Nations Framework Convention on Climate Change, New York, 1992 (UNFCCC)	11-6-1992	25-11-1994 (Ratification)
Convention on Biological Diversity, Rio de Janeiro, 1992	11-6-1992	25-11-1994 (Ratification)
International Tropical Timber Agreement (ITTA), Geneva, 1994	6-7-1995	31-1-1996 (Ratification)
Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985		24-11-1993 (Ratification)
Montreal Protocol on Substances that Deplete the Ozone Layer, Montreal, 1987		24-11-1993 (Ratification)
London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, London, 1990		24-11-1993 (Ratification)
The Convention for the Protection of the World Culture and Natural Heritage, Paris, 1972		29-4-1994 (Acceptance)
Agreement on the Networks of Aquaculture Centres in Asia and the Pacific, Bangkok, 1988		22-5-1990 (Accession)
United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/ or Desertification, Particularly in Africa, Paris, 1994 (UNCCD)		2-1-1997 (Accession)
Convention on International Trade in Endangered Species of Wild Fauna and Flora, Washington, D.C., 1973; and this convention as amended in Bonn, Germany, 1979 (CITES)		13-6-1997 (Accession)
Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, Rome, 1973		8-9-1994 (Acceptance)
ASEAN Agreement on the Conservation of Nature and Nature Resources, Kuala Lumpur, 1985	16-10-1997	
Catagena Protocol on Biosafety, Cartagena, 2000	11-5-2001	
ASEAN Agreement on Transboundary Haze Pollution	10-6-2002	13-3-2003 (Ratification)

International Treaty on Plant Genetic Resources for Food and Agriculture, 2001		4-12-2004 (Ratification)
Kyoto Protocol to the Convention on Climate Change, Kyoto, 1997		13-8-2003 (Accession)
Declaration on ASEAN Heritage Parks	Dec 2003	
Stockholm Convention on Persistent Organic Pollutants (POPs), 2001		18-4-2004 (Accession)
The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat, 1971 as amended in 1982 and 1987		8-11-2004 (Accession)
Establishment of ASEAN Regional Centre for Biodiversity	March 2005	

Source : NCEA 2005.

7. RELEVANT MYANMAR'S RESOURCE MANAGEMENT LAWS

The Environmental Law of Myanmar has been drafted since 2001 but not enacted as yet. Aiming at sustainable forest management and effective biodiversity conservation, and strengthening forest law enforcement and governance, there are two laws in Union of Myanmar. These are, the 1992 Myanmar Forest law (SLORC 1992) and the 1994 Protection of Wildlife, Wild Plants and Conservation of Natural Areas Law (SLORC 1994). Also there are the 2006 Conservation of Water Resources and Rivers Law and the 1994 Myanmar Mines Law. There are also Law Relating to the Fishing Right of Foreign Vessel (1989), Law Relating to Aquaculture (1989), Myanmar Marine Fisheries Law (1990) and Freshwater Fisheries Law (1991). These laws are intended for the development of fisheries, prevention of extinction of fish, safeguarding and preventing environmental degradation and sustainable management of the fisheries.

Today, many ecologically fragile forest areas and endemic species of both flora and fauna are highly endangered and risk extinction. In accordance with the above described two laws, without official permits no one is allowed to hunt, collect and trade in any forest and wildlife species. In 1998, the Forest Department had set Criteria and Indicators for Sustainable Forest Management. The depletion of Myanmar wildlife and forest resources cannot be checked unless serious consideration through Convention on International Trade in Endangered Species of Wild fauna and Flora (CITES) and Convention on Biological Diversity (CBD), and measures adopted urgently (NSDS 2009).

However the politics and forest law enforcement and governance in Kachin State is quite complicated. The State Government literally controls every part of the Kachin State including forest resources. But practically most of the forest areas are controlled by the local armed groups which have made peace agreements with the State Government.

Regarding the code of conduct for Chinese enterprises working in foreign countries, the Global Environmental Institute (GEI) of China in collaboration with concerned authorities, had laid down the guidelines (GEI 2000). That Chinese silvicultural **Guide** applies - to regulating and guiding the whole process of the overseas activities of Chinese enterprises in silviculture, enabling them to protect and develop the global forest resources in a rational, efficient and sustainable way. Logging shall be conducted according to the law and forest destruction or any other unauthorized activity shall be strictly prohibited. The laws and regulations of the host country shall be abided by. The companies concerned shall be equipped with the current texts of laws and regulations

concerning the activities related to silviculture of the host country. The laws and statutes shall be made known to the managers and staff. Fees and taxes payable and make payments on the timely basis according to the law. Forested lands are strictly protected and no illegal transformation of forestland for other purposes shall be tolerated. The company shall ensure the rational investment scope and structure of the sustainable silviculture. The habitat of the species, whose protection has been clearly prescribed by the laws and regulations of the host country, and international conventions, must be protected. No inappropriate collection activities shall be allowed. All the collection activities shall be in conformity with the statutes pertaining to the protection of wild fauna and flora of the host country. All the collection activities shall adopt the methods of sustainable utilization of resources, minimizing the damage of the local resources. Effective measures to be taken to restore, maintain and enhance biodiversity. The relevant conventions and agreements signed by China and the host country shall be observed.

And the Guide also emphasizes on High Conservation Value Forest. A high conservation value forest refers to a forest region rich in biodiversity of global, regional or national significance; a forest region with spectacular scenery of global, regional and national significance; a forest region possessing rare, threatened or endangered ecological system or being encircled in such a system; a forest region being able to meet the basic needs of the local communities; or a forest region playing a significant role in traditional community and cultural identities.

Gold mining being done both legally and illegally which is quite common in Kachin State is very difficult to be dealt with under the complicated resource governance scenario. However the Myanmar Mines Law, 1994, has some provisions for environmental protection including, among others, to protect the environmental conservation works that may have detrimental effects due to mining and there are restrictions for the holder of the mineral production permit, to refrain from any activities which may have detrimental effects to the public. However, during past 3 years, approximately at the end of 2005, water in Ngaw-Chan-Kha changed in color. It is no longer clean and greenish blue, it becomes red and dirty. This horrible result may be due to the chemical waste disposal of metal purifying industry into the river. This metal purifying industry is located in China boundary between N 26' 06' 107" and E 098' 34' 798". It is on the east bank of Ngaw-Chan-Kha river in China boundary above upstream of Gar-lan village in Myanmar boundary. The water in upstream of Ngaw-Chan-Kha river above the metal purifying industry was clean and greenish blue in color. But the water in downstream become red and dirty due to the chemical waste disposal of metal purifying industry into the Ngaw-Chan-Kha river. (See photographs). During past 3 years due to chemical waste disposal from metal purifying industry, water in Ngaw-Chan-Kha river, from Gar-lan village to the place where it drains into Mayhka river, about 70 miles, become red and polluted. Photographs will show the conspicuous difference between the clear water from the springs on both sides of the river flows into the red and dirty water of Ngaw-Chan-Kha and red and dirty water of Ngaw-Chan-Kha flows into the clean water of Mayhka river. Photographs also shows the residues of waste products which deposit on the bank of the river when the water level in the river drops off.

8. BIODIVERSITY RICHNESS IN NORTHERN MYANMAR

From time to time, biogeographic descriptions have been done using available scientific information. In 1998, Bird Life International identified Endemic Bird Areas of the world to give priorities for biodiversity conservation (Stattersfield et al. 1998). The

World Wide Fund for Nature and the World Conservation Union identified the centers of plant diversity of the world with recommended priority areas for conservation of plant diversity (WWF and IUCN 1995). Recently, a conservation assessment of terrestrial ecoregions of the Indo-Pacific based on more available scientific information has come out (WWF 2002). Myanmar's own conservation strategy is just a part of a broader strategy of regional and global biodiversity conservation.

In addition to assessing both negative and positive aspects (App. 2) of construction of dams, scoping of the current EIA on hydropower development of Ayeyarwady River above Myittha, should be much broader and aim at landscape scale level approach and river basin approach. That is if possible to scope the whole Kachin State down to mouth of Ayeyarwady River. Three ecoregions and one world center of plant diversity, seven key biodiversity areas & one conservation corridor, three endemic bird areas & three important bird areas lie in Northern Myanmar.

On account of some constraints, especially the time constraint, the floristic study and vegetation analysis team and faunal team of this study were unable to cover all representative areas of floristically and faunally very rich Kachin State. However they were able to identify some of important and significant species of both flora and fauna which were already recorded.

A. Key Biodiversity Areas and Conservation Corridors (App. 4).

Key biodiversity areas situated in Kachin State are Kakaborazi National Park, Hpokanrazi Wildlife Sanctuary, Bumphabum Wildlife Sanctuary (all belonging to Eastern Himalayan Alpine Shrub/ Meadow Ecoregion and Northern Triangle Temperate Forest Ecoregion); Hukaung Valley Wildlife Sanctuary (Tiger Reserve), Hukaung Valley Extension Wildlife Sanctuary, Khaunglanpu, Namsan Chaung, (all belonging to the Ecoregion- Northern Triangle Sub-tropical Forests-Myanmar); and the Northern Mountains Forest Complex, the prioritized conservation corridor in Kachin State belongs to Northern Triangle Temperate Forest Ecoregion and Northern Triangle Sub-tropical Forests- Myanmar Ecoregion (App.6). The area above Myittha (the Kachin cultural heartland) belongs to the Ecoregion - Mizoram-Manipur Kachin Moist Evergreen Forests. From biodiversity conservation point of view, these key biodiversity areas as a whole in Kachin State is nationally important, regionally significant and globally outstanding.

To compensate the adverse impacts on these biophysically and culturally very important areas on account of construction of dams and to promote sustainable development of Kachin State, the watersheds of Mayhka and Malihka Rivers as a whole must be well managed including the establishment of Mayhka National Park and Malihka National Park.(Fig. 1). This national park should be included in the network of existing Myanmar protected area system (App.5).

B. Ecoregions (App. 7)

1) The Ecoregion - Eastern Himalayan Alpine Shrub and Meadows comprises Bhutan, India, Myanmar and Nepal. This ecoregion is globally outstanding and supports one of the world's richest floral communities. The splendor and richness of these meadow communities in full bloom are difficult to describe. The alpine scrub and meadows in the eastern Himalayas are nested between the tree line at 4000m and the snowline at about 5500m and extend from the deep Kali Gandaki gorge through Bhutan and India's northeastern state of Arunachal Pradesh, to northern Myanmar, including the tallest mountains in the world-Everest, Makalu, Dhaulagiri, Jomolhari (WWF 2002) and also Myanmar's tallest peak Mount Kakabo Rhazi (5729m) is situated in this ecoregion.

The plant richness in this ecoregion sitting at the tip of the world is estimated at more than 7000 species; only the famous rain forests of Borneo are estimated to have a richer flora among the Indo-Pacific ecoregions (WWF 2002). The scrub vegetation of this ecoregion is dominated by colorful *Rhododendron* species that exhibit high species turnover along the west-east gradient from eastern Nepal to northern Myanmar. The characteristic assemblage of northern Myanmar consists of *R. calciphila*, *R. crebriflorum*, *R. chryseum*, *R. riparium*, *R. sanguineum*, and *R. saluenense* is entirely different from Nepal and Bhutan alpine scrublands (WWF and IUCN 1995). The herbs that lend springtime colour to the alpine meadows include hundreds of species from genera such as *Alchemilla*, *Androsace*, *Primula*, *Diapensia*, *Impatiens*, *Draba*, *Anemone*, *Gentiana*, *Leontopodium*, *Meconopsis*, *Saxifraga*, *Sedum*, *Saussurea*, *Rhododendron*, *Potentilla*, *Pedicularis*, and *Viola* (WWF and IUCN 1995).

The fauna of this Ecoregion - Eastern Himalayan Alpine Shrub and Meadows is said to be surprisingly rich in mammals and birds and Myanmar portion of the ecoregion should be biologically explored by both native and expatriate scientists. Important mammal species in this region include the snow leopard, blue sheep, Himalayan tahr, and takin and avian predators such as the lammergeier, Himalayan griffon, black eagle, and northern goshawk (WWF 2002).

The Vespertilionid bat and the Chestnut-breasted partridge are near-endemic to this ecoregion (WWF 2002). 100 mammal species are known in this ecoregion and threatened species are snow leopard, takin, Himalayan goral, serow, Himalayan tahr (WWF 2002). Alpine meadows and scrub provide breeding habitats for such bird species as Himalayan and Sclater's Monals, Grandala, Alpine Accentor and a number of finches (Robson 2000). 115 bird species are known in this ecoregion and there are several high elevation specialists such as, the Himalayan snowcock, Tibetan partridge, snow partridge, Satyr tragopan and the Himalayan griffon, that need conservation attention (WWF 2002).

Based on the information from expeditions carried out by both national and expatriate ornithologists, the following species are currently found (S.Chan, T.Aung, N.M.Shwe, pers.comm.) namely, *Lophophorus sclateri*, *Sitta Formosa*, *Aceros nipalensis* (Hkakaborazi National Park). Trans-boundary protected areas with adjoining countries should be considered in the interest of both global and regional significance.

2) The Ecoregion-Northern Triangle Temperate Forests lies in the extreme northern area of the northern Triangle of Myanmar. There have been no scientific surveys yet in this region except done by Kingdon-Ward, 50 to 80 years ago (Kingdon-Ward 1921, 1930, 1952). The biodiversity of this area may be very high and many scientists hope to find species new to science. Satellite imagery indicates that the ecoregion is still virtually clothed in intact forests and presents a rare opportunity to conserve large landscapes that will support the ecological processes and the biodiversity within this eastern Himalayan ecosystem. The Chindwin, Malihka, and Mayhka rivers originate in these mountains and flow south to converge in the lower reaches to form the Ayeyawady River.

Biologically, the mountains are an ecotone of the Assam-Indian, Eastern Himalayan, Indo-Malayan, and Chinese floras and also Gondwana-era relicts have taken refuge here (WWF 2000). Thus, floristically, the ecoregion is extremely diverse and the complex topography, moist conditions by south-western monsoon funneled from Bay of Bengal has provided the localized climatic variations that promote endemism (WWF 2002). Floristically, the temperate forests lie between 1830 and 2700m. At lower elevations the forest transition into the subtropical forests and in the upper elevations, into the subalpine conifer forests. The temperate forests are characterized by *Alnus nepalensis*,

Betula cylindrostachya, *Castanopsis* sp., *Schima* sp., *Michelia* sp., and *Bucklandia populnea* (WWF and IUCN 1995), Lwin 1995). At higher elevations rhododendrons, especially *Rhododendron decorum*, *R. magnificum*, *R. bullatum*, *R. crinitum*, *R. neriiflorum* are dominant in the vegetation (WWF and IUCN 1995).

At elevations above 2100m, the broadleaf forests transition into a mixed forest, where species of *Quercus*, *Magnolia*, *Acer*, *Prunus*, *Ilex*, and *Rhododendron* are mixed with

Picea brachytyla, *Tsuga dumosa*, *Larix griffithiana*, and *Taiwania flousiana*. The rich, diverse shrub flora is characterized by species of *Acer*, *Berberis*, *Clethra*, *Enkianthus*, *Euonymus*, *Hydrangea*, *Photinia*, *Rhododendron*, *Rubus*, *Betula*, and *Sorbus* (WWF and IUCN 1995).

Almost 100 species of mammals are known in this ecoregion and endemic mammals are the Gongshan muntjak and Fea's muntjak. However there are several other threatened species that deserve conservation attention, namely the tiger, takin, clouded leopard, red panda, wild dog, Asiatic black bear, stump-tailed macaque, capped leaf monkey, red goral, great Indian civet, back-striped weasel, Ayeyawady squirrel, and parti-colored squirrel (WWF 2002).

This ecoregion overlaps with the Eastern Himalayas endemic bird area (130) that contains seven restricted-range species (Stattersfield et al. 1998). 362 birds are known from this ecoregion, and the Rusty-bellied Shortwing is the only ecoregional endemic but there are several species that deserve conservation attention as they require mature habitats and have low tolerances for disturbances that are indicators of habitat integrity (WWF 2002). Some of these species include the Oriental Pied-Hornbill, Wreathed Hornbill, Blyth's Tragopan, Himalayan Flameback, and Sclater's Monal (WWF 2002). The Sclater's Monal is vulnerable and according to Robson (2000), it is uncommon local resident, east of northern Myanmar and its status should be checked in this ecoregion.

3) The Ecoregion- Northern Triangle Subtropical Forests sits in the remote Triangle in northern Myanmar. In terms of species and biological richness this ecoregion is globally outstanding and floristically one of the most diverse regions in continental Asia (WWF and IUCN 1995). Scientifically it is the least explored except the early explorations of Kingdon-Ward in 19th Century (Kingdon-Ward 1921, 1930, 1952 quoted in WWF 2002). Biodiversity richness is highly underestimated and the place may likely harbour many more species than now attributed to it. The westernmost Sangpang Bum range forms the Indo-Myanmar boundary and the easternmost Gaoligong Shan demarcates the Myanmar-China border. Generally, the elevation exceeds 1500m but the peaks rise steeply to over 3000m. The Chindwin, Malihka and Mayhka rivers originate in these mountains and converge in the lower reaches to form the Ayeyawady River. With varied topography and biogeographic settings this ecoregion is at the crossroads of Assam-Indian, Eastern Himalayan, Indo- Malayan and Chinese flora, and also mingled with Gondwana relicts that have taken refuge here (WWF 2002), resulting in with a high floral diversity. The Indo-Malayan elements are now restricted to the river valleys, below 2400m, with the Indo-Himalayan flora stratified above (WWF and IUCN 1995).

The Ecoregion - Northern Triangle Subtropical Forests consists of subtropical broadleaf forests, subregional-scale patches of temperate broadleaf forests, subalpine conifer forests, and alpine meadows in the northern area (WWF and IUCN 1995). The subtropical forests are found between 500m and 1600m and commonly found are species of Magnoleaceae, Lauraceae and Dipterocarpaceae make up the associations below 915m, and species of Fagaceae, Meliaceae, tree ferns and climbing palms comprise the upper elevation associations(WWF and IUCN 1995). In these forests the

characteristic tree species are *Acer pinnatinervium*, *Aesculus assamicus*, *Betula alnoides*, *Carpinus viminea*, *Castanopsis argentea*, *Magnolia pterocarpa*, *Persea* spp., *Litsea* spp., and *Lindera* spp. (WWF and IUCN 1995). In mature forests, trees are draped with lianas (*Jasminum duclouxii*, *J. pericallianthum*, *Lonicera hildebrandii*, *Bauhinia* spp., *Mussaenda* spp., *Rubus* spp.) along the upper limits above 1525m; the forest is characterized by a predominance of *Bujcklandia populnea* (WWF and IUCN 1995).

The Ngawchang valley at 1000m and 1980m between Htawgaw and Ganfang in the western part of the ecoregion, has a pine-oak association that is characterized by *Pinus kesiya*, *Quercus incana*, and *Q. griffithii*, (WWF and IUCN 1995). A rich unique herb flora of *Anemone begoniifolia*, *Gentiana cephalantha*, *Gerbera piloselloides*, *Inula cappa*, *Lilium bakerianum*, *L. ochraceum*, *Primula denticulate*, *Senecio densiflora* grows in these open forests, considered a fire-maintained pre-climax community (WWF and IUCN 1995). Several endemic species are associated with these forests, including the terrestrial orchid *Paphiopedilum wardii*, and other endemics such as *Agapetes adenobotrys*, *A. pubiflora*, *Brachytome wardii*, *Lactuca gracilipetiolata*, *Lasianthus wardii*, *Paphiopedilum wardii*, *Strobilanthes stramineus* (WWF and IUCN 1995).

The Ecoregion - Northern Triangle Subtropical Forests harbours about 140 species of mammals (WWF data base 1999), including eight ecoregional species; Fea's muntjak, two squirrels, and Pere David's rock squirrel, two moles, Styan's water shrew, a Vespertilionid bat, and a murid rodent. Other species of conservation importance include, tiger, red panda, Asian elephant, gaur, takin, southern serow, pig-tailed macaque, Asamese macaque, stump-tailed macaque, capped leaf monkey, hoolock gibbon (primates are invaluable indicators of forest condition), wild dog, Asiatic black bear, back-striped weasel, great Indian civet, clouded leopard, red goral, Ayeyawady squirrel and particoloured squirrel (WWF 2002). During 1997, *Muntiacus putaoensis* was discovered during wildlife survey in the region. The bird fauna exceeds 370 species (WWF 2002). The Rusty-bellied Shortwing (*Brachypteryx hyperythra*) is this ecoregional endemic species and other focal species because of their need for mature forests and low thresholds of disturbance include Blyth's Tragopan (*Tragopan blythii*), Great Hornbill (*Buceros bicornis*) and the Wreathed Hornbill (*Aceros undulates*) and rufous-necked hornbill *Aceros mipalensis* (WWF 2002). Since the endangered White-winged Duck (*Cairina scutulata*) was found in northern Myanmar (Robson 2000) and (Thein Aung.pers.comm.) the status of this species should be checked in this ecoregion. Hooded Treepie (*Crypsirina cucullata*), an endemic species of Myanmar and vulnerable Blyth's Tragopan (*Tragopan blythii*), Hume Pheasant (*Syrmaticus humiae*) should be always monitored in this ecoregion. Also the status of vulnerable Ward's Trogon (*Harpactes wardi*) should be checked in broadleaved evergreen forests of this ecoregion.

Hukaung Valley Wildlife Sanctuary is situated in this ecoregion and the presence of tigers has been reported recently. The status of vulnerable Masked Finfoot (*Heliopais personata*), Indian Skimmer (*Rynchops albicollis*) Blyth's Kingfisher (*Alcedo hercules*) should be checked in rivers, pools and lakes of this ecoregion. In streams, rivers and water areas near broadleaved evergreen forests, the vulnerable and winter visitor, Wood Snipe (*Gallinago nemoricola*) and vulnerable Blyth's Kingfisher should be checked in these ecoregions. In tall grass and lowland habitats of this ecoregion, the status of vulnerable Jerdon's Babbler should be studied.

In accordance with the expeditions carried out by national and expatriate ornithologists, the following bird species are currently confirmed (S. Chan, T.Aung, N.M.Shwe, K.M.M.Thwin, H. Hla, pers. comm.) within this ecoregion, namely, *Pelecanus*

philippensis, *Leptoptilos javanicus*, *Aythya baeri*, *Grus antigone*, *Haliaeetus leucoryphus*, *Aythya nyroca*, *Phalacrocorax niger* (Indawgyi Bird Sanctuary), *Pelecanus philippensis*, *Ardea insignis*, *Leptoptilos javanicus*, *Cairina scutulata*, *Gallinago nemoricola*, *Pavo muticus*, *Aceros nipalensis*, *Phalacrocorax carbo*, *Anhinga melanogaster*, *Pelecanus philippensis* (Hukaung Valley Wildlife Sanctuary), *Tragopan blythii*, *Lophophorus sclateri*, *Stachyris oglei*, *Ardea insignis*, *Brachypteryx hyperythra*, *Sitta Formosa*, *Aceros nipalensis*, *Alcippe ludlowi*, *Sphenocichla humei* (Hponkan Razi Wildlife Sanctuary), *Gyps bengalensis*, *Gyps indicus*, *Pelecanus philippensis*, *Pavo muticus*, *Leptoptilos javanicus*, *Grus grus*, *Ciconia nigra* (Kamaing and Mogaung areas in Kachin State), *Pelecanus philippensis*, *Leptoptilos javanicus*, *Anas Formosa*, *Heliopais personata*, *Phalacrocorax carbo*, *Anhinga melanogaster*, *Grus grus*, *Ciconia nigra*, *Anser indicus*, *Tadorna ferruginea*, *Aythya nyroca*, *Glareola lactea* (Ayeyawady River section between Myitkyina and Sinbo), *Gyps bengalensis*, *Grus grus*, *Ciconia nigra*, *Ardea insignis*, *Cairina scutulata* (Tawlawgyi and Nam Sam Chaung areas in Kachin State), *Pelecanus philippensis*, *Cairina scutulata*, *Gyps bengalensis*, *Pavo muticus* (Htamanthi Wildlife Sanctuary, and Uyu River in Sagaing Division).

C. World Centers of Plant Diversity (CPD)

Renowned botanists claimed that significance of plants as determinants of conservation priorities is unrivalled and have produced centers of plant diversity or the most important sites for plants worldwide (WWF & IUCN 1995). The flora of Northern Myanmar had been studied from time to time, but with big time gaps and not continuously on account of remoteness of the region and less encouragement. According to Kalaya Lu (2006), Reginald Farrer collected 118 seeds or specimens of Myanmar rhododendrons in 1920 and *plant* hunters George Forrest and F. Kingdom Ward were the pioneer plant collectors at Northern extremities of Myanmar during 1921-1953. F. Kingdom Ward collected more than 150 species of Myanmar *Rhododendron*. and he wrote about it and his floral expeditions in famous books, *Return to Irrawady* (1956) and *Burma Icy Mountain* (1923). In 1981 Dr. Kyaw Soe and two members from Botany Department, Yangon University, undertook a botanical expedition in Northern Myanmar and collected specimens including medicinal plants (K. Soe 1982).

From regional and global perspectives, Myanmar has four world centers of plant diversity (WWF and IUCN 1995). North Myanmar is one of the world centers of plant diversity.

North Myanmar (CPD)

Location: This CPD is located - North of latitude 25° 00'N and between longitudes 96° 45'E, including the whole of Kachin State, and the northern part of Sagaing Division. It comprises the Kachin Hills, the Angpawng Bum and associated ranges and river systems. The area is about 115,712 km² (WWF and IUCN 1995) and altitudinal ranges between about 150-5881m, Mount Kakaborazi is the summit. This region adjoins two other CPD sites (WWF and IUCN 1995), namely, Namdapha (IS4) in India and the Gaoligong Mountain, Nujiang River and Biluo Snow Mountains region (EA26) in China. There are only two extensive areas of lowland in North Myanmar, the Hukaung Valley in the west and the basin of the Malihka. Most areas apart from these valleys are above 1500m. Some of the highest peaks are, Hkakaborazi (5881m), Saramati (3862m), Bumba Bum (3411m), Chingwin Bum (3292m), and Nanggum Bum (3204). Principal rivers are the Chindwin, Malihka and Mayhka.

Vegetation: The forest types are lowland tropical forest, various types of monsoon forest, mixed and coniferous temperate forest, *Rhododendron* forest and alpine

meadows. The description of vegetation of the area is mainly relied on information of Kingdon-Ward (1944, 1945, 1946) and Pottinger and Prain (1898, quoted in WWF and IUCN 1995). Kingdon-Ward (1944, 1945) identified main vegetation types, which are described briefly below.

Tropical evergreen rain forest occurs up to 600m altitude on the Hkamti Plain and in the bottoms of the lower Malihka, the Nam Tisang and the Mayhka Rivers. The forest is almost entirely Indomalayan in composition and typical tree species are *Mesuaferrea*, *Stereospermum personatum*, *Terminalia myriocarpa*, *Dipterocarpus alatus*, and *D. turbinatus*. Pandans such as *Pandanus furcatus* and palms such as *Caryota urens*, strangling figs such as *Ficus elastica* and *F. benjamina*, tree ferns, lianes and climbers including the spectacular *Thunbergia grandiflora*.

Subtropical hill forest occurs at 450-1675m and the upper limit is defined by the lower limit of *Bucklandia populnea*, which is found only above 1525m. The forests include Magnoliaceae, Lauraceae, Dipterocarpaceae, Fagaceae, Meliaceae, tree ferns, and climbing palms. Characteristic tree species include *Acer pinnatinervium*, *Aesculus assamicus*, *Betula alnoides*, *Carpinus viminea*, *Castanopsis argentea*, and *Magnoliapterocarpa*. Lianas include *Jasminum duclouxii*, *J. pericallianthum*, *Lonicera hildebrandii*, and species of *Bauhinia*, *Clematis*, *Mussaenda* and *Rubus*. Terrestrial orchids include *Cypripedium villosum* (endemic to Myanmar) and *Paphiopedilum wardii* (a strict endemic) and although the vegetation is Indomalayan in character, the flora above 1525m includes many Eastern Asiatic elements (WWF and IUCN 1995).

Subtropical pine- oak forest occurs at 1000-1980m and dominant trees are *Pinus kesiya*, *Quercus incana*, *Q. serrata*, *Q. griffithii*. The herbaceous flora includes *Anemone begoniifolia*, *Gentiana cephalantha*, *Gerbera piloselloides*, *Inula cappa*, *Lilium bakerianum*, *L. ochraceum* var *burmanicum*, *Primula denticulate* and *Senecio densiflora*.

Temperate rain forest (monsoon forest) includes warm temperate, cool temperate and temperate pine forests. Warm temperate rain forest occurs at 1525-2135 m in areas with distinct spring and winter seasons, with little snow in winter. Typical trees are *Alnus nepalensis*, *Betula cylindrostachya*, *Bucklandia populnea* and some palm like arboreal Araliaceae. The epiphytic shrub flora is very rich including species in the Maddenii and Vaccinioides series of *Rhododendron*.

Cool temperate rain forest occurs at 1830-2440m. The indicator is the appearance of the main belt of large shrub rhododendrons, such as *R. decorum*, *R. magnificum*, *R. bullatum*, *R. crinitum* and *R. neriiflorum*. These flower mainly in February and March, coinciding with a major bird migration (WWF and IUCN 1995).

Temperate pine forest occurs at 1370-2440m and the dominant species is *Pinus excelsa*. This species is found on slopes and also within broadleaf forests of *Acer*, *Ilex*, *Laurus*, *Prunus* and *Quercus*. There is thick bamboo undergrowth and woody climbers include *Aristolochia griffithii*, *Clematis forrestii* and *Paederia foetida*.

Mixed temperate forest occurs at 2135-2745m and it is transitional between broadleaf temperate rain forest below and *Abies* (silver fir) forest above. The dominant genera are *Quercus*, *Magnolia*, *Acer*, *Prunus*, *Ilex*, and *Rhododendron* and coniferous species include *Picea brachytyla*, *Tsuga dumosa*, *Larix griffithiana* and *Taiwania flousiana*. The shrub flora is very diverse, including species of *Acer*, *Berberis*, *Clethra*, *Enkianthus*, *Euonymus*, *Hydrangea*, *Photinia*, *Rhododendron*, *Rubus* and *Sorbus*. The notable species of ground flora is *Chamaepericlymenum suecicum*, an arctic-alpine relict (WWF and IUCN 1995).

Silver fir forest occurs at 2745-3660m and at this altitude, deep snow lies for at least a month. The forest is dominated by *Abies fargesii*, and also with species of *Acer*, *Betula*, *Rhododendron*, and *Magnolia*. At higher altitudes the forest is more open and bamboo (*Arundinaria*) thickets occur. In open meadows, tall alpine herbs *Lilium giganteum*, *Meconopsis paniculata* and *Notholirion campanulatum* are found. From 3050m upwards, primulas increase with species such as *P. agleniana* var. *thearosa* (the tea-rose primula endemic to the Seinghku Valley), *P. calthifolia*, *P. eucyclia*, and *P. sikkimensis*.

Subalpine rhododendron scrub occurs between 3350-3960m and at least 20 species of *Rhododendron* are known to occur. The dominant above 3350m is *R. selense* with pink and cream flowers in spring. At least 12 dwarf species of *Rhododendron* are found in north Myanmar, about half are confined to subalpine scrub. A very wide range of herbaceous alpine plants is found including *Caltha palustris*, *Cypripedium tibeticum*, *Nomocharis souliei*, *Omphalogramma souliei*, and several primulas.

Alpine vegetation occurs between 3660 - 4575 m. Shrubs of several dwarf rhododendrons such as *R. calciphila*, *R. crebriflorum*, *R. chryseum*, *R. riparium*, *R. sanguineum*, and *R. saluenense* and *Cassiope fastigiata*, *Potentilla fruticosa* and *Rosa sericea*. The main herbaceous genera include *Alchemilla*, *Androsace*, *Anemone*, *Diapensia*, *Draba*, *Gentiana*, *Leontopodium*, *Pedicularis*, *Saussurea*, *Saxifraga* and *Viola*. Screes are colonized by species which have very long tap roots include *Picrorhiza scrophulariiflora* and *Oresolen wattii* (WWF and IUCN 1995).

Flora and Endemism: At least 6000 species were estimated by Kingdon-Ward who had made eight journeys there between 1914 and 1942. George Forrest explored the Upper Salween (Thanlwin), Mayhka and Shweli-Salween divides from the Yunnan side between 1917 and 1930, Reginald Farrer made collections in the Htawgaw area of extreme north-east Myanmar and other collectors who have visited parts of the area included Pottinger and Prain in 1898 and Burmese foresters, U Tha Hla and U Chit Ko Ko (WWF and IUCN 1995).

Floristically, the area is one of the richest and most diverse in mainland Asia. It is the meeting point of four distinct floras; the Assam-Indian the Eastern Himalayan, the Indomalayan, and the Chinese. Endemism is significant in most altitudinal zones including remarkable species such as a unique epiphytic lily, *Lilium arboricola*. According to WWF and IUCN 1995, the following are examples of *endemics* of each vegetation type:

Tropical evergreen forest: *Agapetes wardii*, *Albizia vernayana*, *Camellia stenophylla*, *Strobilanthes areniculus* and *Syzygium cuttingii*.

Subtropical hill forest: *Agapetes adenobotrys*, *A. pubiflora*, *Brachytome wardii*, *Lactuca gracilipetiolata*, *Lasianthus wardii*, *Paphiopedilum wardii*, and *Strobilanthes stramineus*.

Subtropical pine forest: *Paphiopedilum wardii*, *Primula densa*, and *Stemona wardii*.

Warm-temperate rain forest: *Aeschynanthus wardii*, *Aster helenae*, *Diplycosia alboglaucula*, *Ixora kingdon-wardii*, *Leycesteria insignis*, *Litsea cuttingii*, *Primula dictyophylla*, *Rhododendron dendricola*, and *Sorbus paucinervis*.

Cool-temperate rain forest: *Euonymus burmanica*, *Primula burmanica*, *Rhododendron agapetum*, *R. insculptum*, *R. magnificum*, *R. taggii*, and *Rubus chaetocalyx*.

Mixed temperate forest: *Acer taronense*, *Berberis hypokeriana*, *Ilex burmanica*, *Juniperus coxii*, *Prunus kingdon-wardii*, *Rhododendron butyricum* and *R. vesiculifolium*.

Silver fir forest: *Berberis burmanica*, *Gaultheria minuta*, *Primula eucyclia*, *P. agleniana* var. *thearosa* and *Sorbus wardii*.

Rhododendron scrub: *Cremanthodium wardii*, *C. farreri*, *Meconopsis violaceae* and 4 species of *Rhododendron*.

Alpine vegetation: Apparently few endemics, but among them *Primula fea*.

According to WWF and IUCN 1995, North Myanmar is a center of diversity for several genera of Ericaceae, including *Agapetes*, *Rhododendron* (more than 80 species), *Vaccinium*, *Rubus* (24 species), *Sorbus* (at least 20), *Prunus* (at least 11), and *Pedicularis* (more than 10). Also there is one monotypic, near-endemic family, Dipterocarpaceae (*Dipentodon sinicus*), which also occurs in adjacent China.

Useful plants: Regarding timber- the most heavily exploited trees is *Taiwania flousiana*, the wood is exported to China to make coffins, and other timber species include *Pinus kesiya* and some *Castanopsis* species. Oil- from *Ricinus communis*, used in lamps. A dark blue dye is obtained from *Strobilanthes flaccidifolius*, while *Rubia manjith* yields a particular deep red madder dye. Beer is obtained from rice, *Sterea* and *Eleusine*. *Caryota urens* is used by Kachins to construct the walls and floors where bamboos are scarce. The Marus boil and eat the pith of the stem as a kind of sago. Bamboos are used for carrying water, for making ropes, matting, bows and arrows. *Arundinaria* is used to make walking sticks and pipe bowls. Some of the rattan palms of the tropical and subtropical forest zones are used to make suspension bridges (WWF and IUCN 1995). Rosaceae contains several plants of food value, including *Cydonia cathayensis*, *Fragaria elatior* and many species of *Rubus*. Medicinal plants- Many plants are used as medicines by specific tribes. *Fritillaria roylei* and *Coptis teeta* are widely used for the treatment of malaria and as a tonic or aphrodisiac. These two species are dug up in vast quantities and exported to China and also to Mandalay and Yangon. Sometimes the whole medicinal plant species are used but sometimes particular parts are used for their different medicinal properties but are mostly traded in their raw and dried forms (TRAFFIC 2008).

D. Endemic Bird Areas (EBA) and Important Bird Areas (IBA)

EBA means an Endemic Bird Area as an area which compasses the overlapping breeding ranges of restricted-range bird species, such that the complete ranges of two or more restricted-range species are entirely included within the boundary of the EBA. This does not necessarily mean that the complete ranges of all of an EBA's restricted range species are entirely included within the boundary of that single EBA, as some species may be shared between EBAs.

There are 4 EBAs in Myanmar. The study area of "EIA special investigations on Hydropower development of Ayeyawady Basin above Myitkyina" lies in the range of three endemic bird areas and one secondary area namely;

- 1) Eastern Himalayas EBA no 130
- 2) Ayeyawady plains EBA no 132
- 3) Yunnan mountains EBA no 139
- 4) North Myanmar lowlands (Secondary area)

IBA means an Important Bird Area where the site is known or thought regularly to hold significant numbers of a globally threatened species; the site is known or thought to hold a significant component of a group of species whose breeding distributions define an Endemic Bird Area (EBA) or a Secondary Area (SA); the site is known or thought to hold a significant component of the group of species whose distributions are largely or

wholly confined to on biome; a site may qualify as an IBA under any one or more of the four criteria listed below: a) the site is known or thought to hold, on a regular basis, 1% or more of a biogeographic population of a congregatory waterbird species, b) the site is known or thought to hold, on regular basis, 1% or more of the global population of a congregatory seabird or terrestrial species, c) the site is known or thought to hold, on a regular basis, at least 20,000 waterbirds, or at least 10,000 pairs of seabird, of one or more species, d) the site is known or thought to be a "bottleneck site" where at least 20,000 raptors (*Accipitriformes* and *Falconiformes*) and/ or cranes (*Gruidae*) pass regularly during spring and/ or autumn migration.

There are 53 IBA in Myanmar. There are 12 IBAs in the Kachin state. The study area lies adjacent to 3 IBAs namely 1) Hkakaborazi National Park; 2) Hponkanrazi Wildlife Sanctuary; 3) Bumphabum Wildlife Sanctuary. These three IBAs together form an important portion of priority corridor for conservation in Myanmar known as Northern Mountains Forest complex (Tordoff et.al 2005). The water shed areas of both Mayhka and Malihka rivers originate from these IBAs.

9. POTENTIAL IMPACTS ON BIODIVERSITY

Ecoregions which are nationally important, regionally significant and globally outstanding and wildlife species will be heavily disturbed and directly affected by clearing and logging of the inundation areas and follow-up construction activities for a series of dams in Kachin State. Of particular concern are loss and fragmentation of important ecosystems and the loss of key, endemic and endangered species of both flora and fauna. While most birds and mammals can be expected to disperse at the initiation of clearing and logging, some will inevitably be trapped by hydropower development activities. And thus are likely to affect long range movements of large mammals. The dam sites and watersheds of Malihka and Mayhka Rivers are within the core area for strict biodiversity conservation, and the dams and related facilities are close and within eco-regions (App.7), key biodiversity areas (App.4) and conservation corridors (App.6) and in one of the world's centers of plant diversity (WWF & IUCN 1995). Definitely there will be negative impacts on potential of availability of traditional medicinal plants. Regarding agro-biodiversity there may be potential negative impacts on some wild rice varieties and their ancestors which are thriving well in Chebwe Township (Kalaya Lu 2006). The area has been extensively disturbed by past logging and shifting cultivation, and currently by poaching, so the additional disturbance caused by the hydropower project is expected to add more negative impacts. Some of the reservoir areas are not central to the livelihoods of most of the local villagers, even though wildlife hunting is thought to be intense. In the future when the constructions start huge influx of Chinese workers is imminent and there is a strong possibility of severe deforestation for fire wood. Another serious factor to consider is bush meat consumption. At the moment bush meat consumption is not very high. Local hunters usually hunt for daily subsistence and if there an extra they sell it to other people. But during construction period there will be an increase of Chinese workers, the majority fond of bush meat. Therefore bush meat demand will be increased. The majority people of local races oppose construction of the dams especially Myison hydropower project. They consider the confluence as the cultural heartland of the Kachins.

10. IMMEDIATE COMPENSATORY MEASURES

On account of the construction of a cascade of hydropower dams in Kachin State, there will be severe negative impacts on regionally significant and globally outstanding three

ecoregions, one center of world plant diversity; severe impacts on key biodiversity areas and conservation corridors of Myanmar; severe impacts on livelihoods and habitations of grassroots people of the region; disappearance of some wild rice varieties and their ancestors; disappearance and forever loss of the cultural heartland of Kachin people (Myitsone); reduction of ecotourism potential and loss of ecotourism sites and cultural sites in Kachin State; and some wildlife species, terrestrial and wetland ecosystems may suffer considerably due to deforestation, loss of typical habitats and habitat fragmentation. These must be compensated by following prioritized actions if constructions of dams are going to be approved in Kachin State.

Prioritized Action 1

Create and implement new protected area management and watershed management in the whole watershed areas of Malihka River and Mayhka Rivers. CISPDR/CPI will provide funds for protected area management and watershed management of both Malihka and Mayhka Rivers as a whole during the hydropower development phase. The whole catchment area of Ayeyawady is about 49000 km² and out of which the following will be recommended as prioritized actions (1) Establishment of Malihka NP (4040 km²) and Mayhka NP (6854 km²), encompassing Imaw Bum (the area with floral wealth is vital water source of Maykha and Ngaw Chan Hka Rivers, and is floristically strategic linkage between east and west Himalayan floral communities) which will be included in the protected area network of Myanmar(App.5), managed by Nature and Wildlife Conservation Division of Forest Department, Union of Myanmar (2) Watershed management of the remaining area (23643 km²) which will be managed by Watershed Division of Forest Department, Union of Myanmar. This prioritized action could be done by collaborating between Ministry of Forestry, Ministry (I) of Electrical Power and China Power Investment Corporation (CPI). When the hydropower project becomes operational, approximately 1 percent of the annual proceeds from the sale of electricity will be provided to support Malihka NP & Mayhka NP and watershed management in Kachin state. If the annual fund provision is to be in excess of funds required for maintenance of Malihka NP & Mayhka NP and watershed management, a plan will be formulated to place the remaining funds in a "conservation fund" to be used for priority conservation programs nationwide. This is one of the exploring ways to establish a national conservation fund.

This prioritized action should be under a management team of various stakeholders including government authorities and departments of Myanmar, concerned Chinese corporations, scientific institutions from both China and Myanmar, environmental NGOs from both Myanmar and China, and local communities representing major races and various ethnic minorities of Kachin State. This prioritized action can offer more efficient dams and better protection of biodiversity, thus enhancing MDGs.

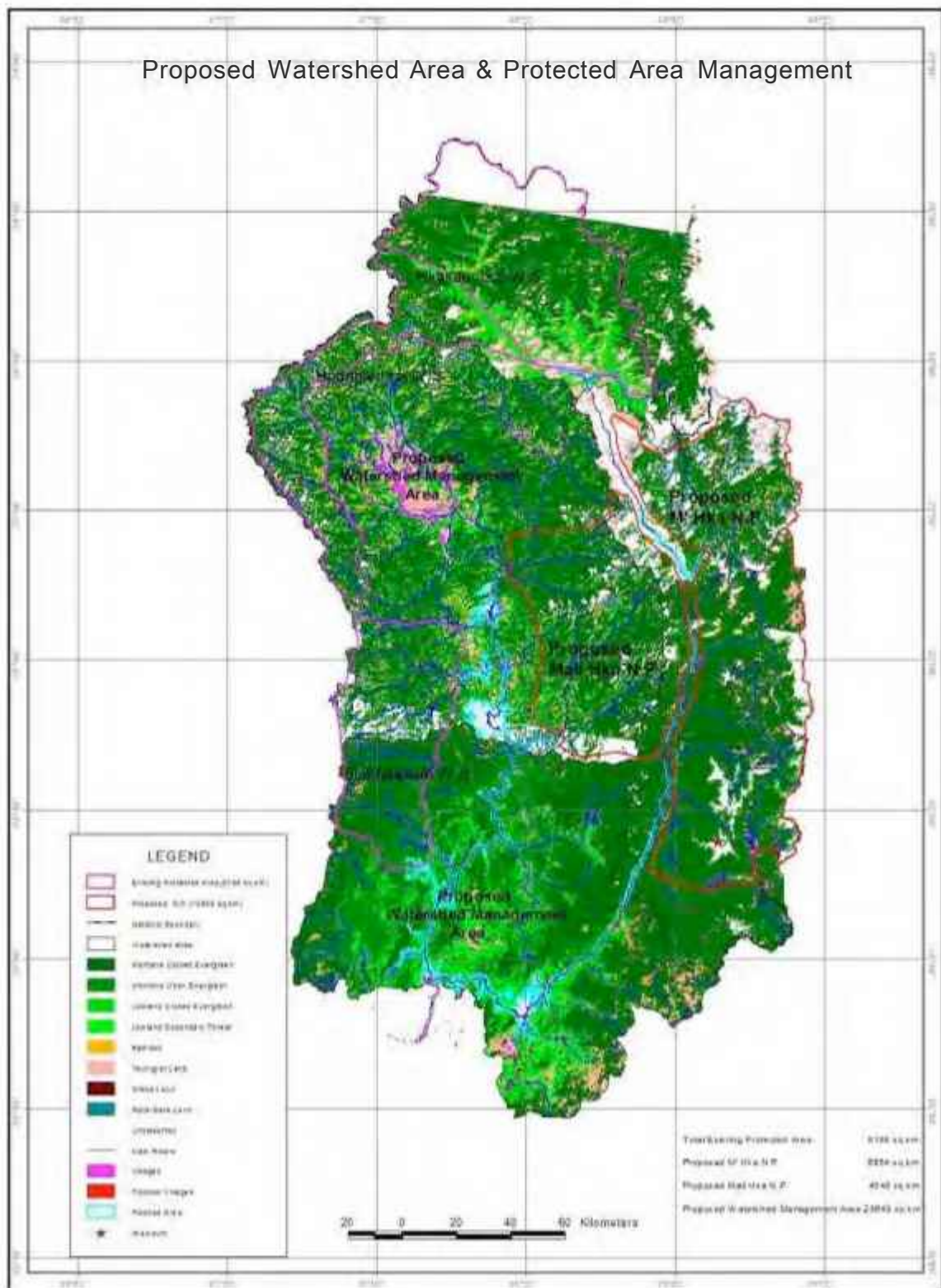


Fig. 1. Proposed watershed area and protected area management.

Prioritized Action 2.

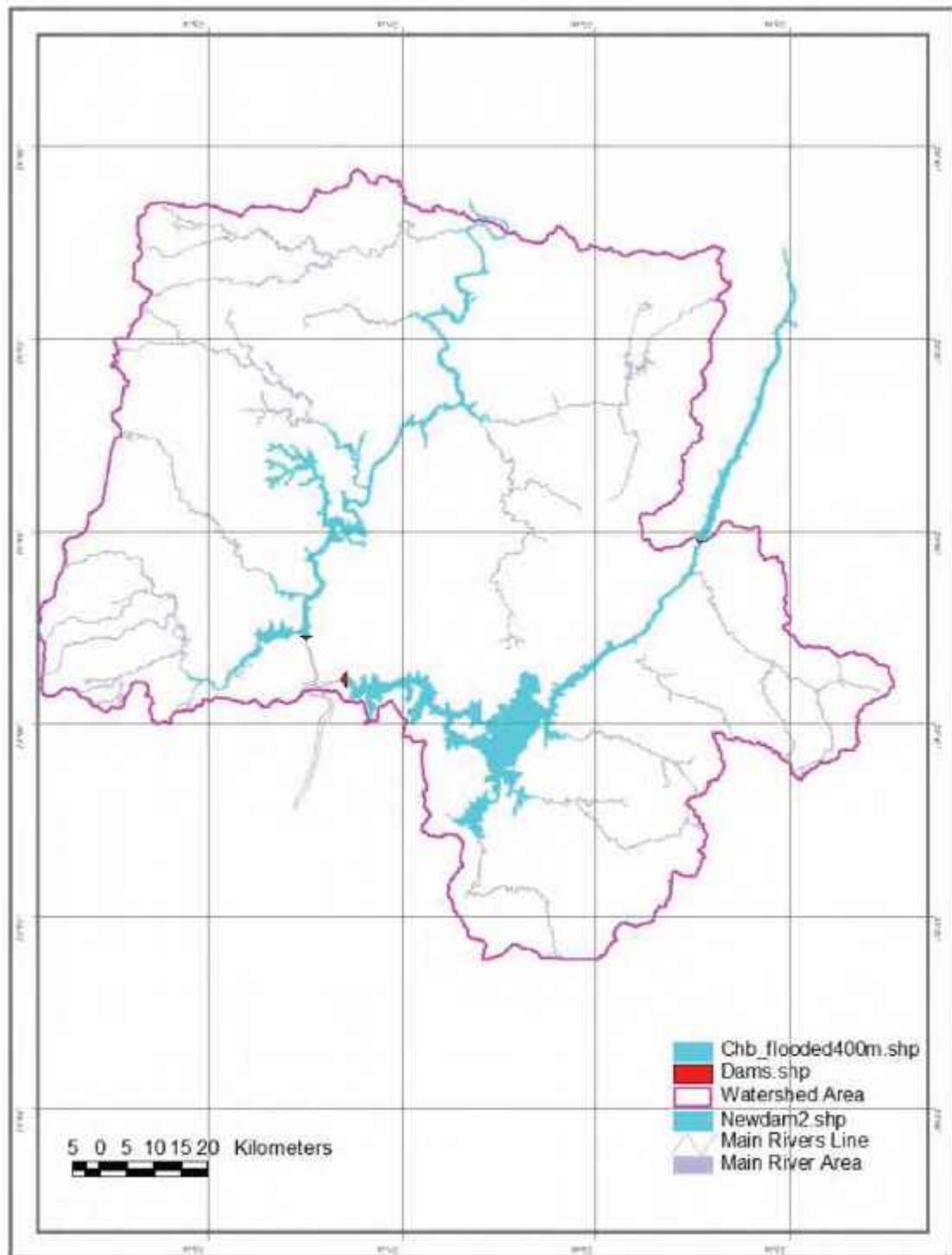


Fig. 2. Proposed alternative dam sites

With experts, find an alternative option to avoid construction of Myitsone Dam at the confluence. The best option would be to develop two smaller hydropower dams substituting already proposed Myitsone Dam and its location at appropriate two

locations above the confluence of Malihka and Mayhka rivers. Selecting and identifying two dam sites, above the confluence, one on the Mayhka River and another on the Malihka River (see above map) shall avoid disappearance of the culturally very important confluence. Conducting social impact assessment is essential and the public should be disclosed about the hydropower dams and resettlement programs by having public meetings.

The new option of construction of two dams above the confluence, replacing the original proposed Myitsone dam may result in the following 16 flooded villages according to our GIS map analysis:

Hpala; Wang rong; Ri dam; Ma ga ta; Sum pi yang; Hpung in yang; Khin du yang; Ma li yang; Ja ya yang; Ning ma; N krung tu; Lot mai yang; Ale aung; Mung dong; Htunggoirn; and Gamgo.

The original proposed Myitsone Dam project may result in 32 villages will be flooded.

Prioritized Action 3

The roads from Myitkyina to Putao, and from Myitkyina to Chebwe will be flooded. These need to find new alignments which are clear of flooding and to build two new roads. In other words as compensation, it is essential to build new roads and bridges replacing the ones which are going to be submerged. One section of road to Putao from Myitkyina i.e from Tang Pe to Tiangzup approximately 30 miles will be submerged. Similarly a section of Myikyina - Chibwe road about 40 miles will also be submerged. The 59th mile bridge, Sha Ngaw Bridge on the way from Myikyina to Chibwe; Inzup Bridge, Tianzup Bridge and some small bridges on the road from Myitkyina to Putao will be flooded.

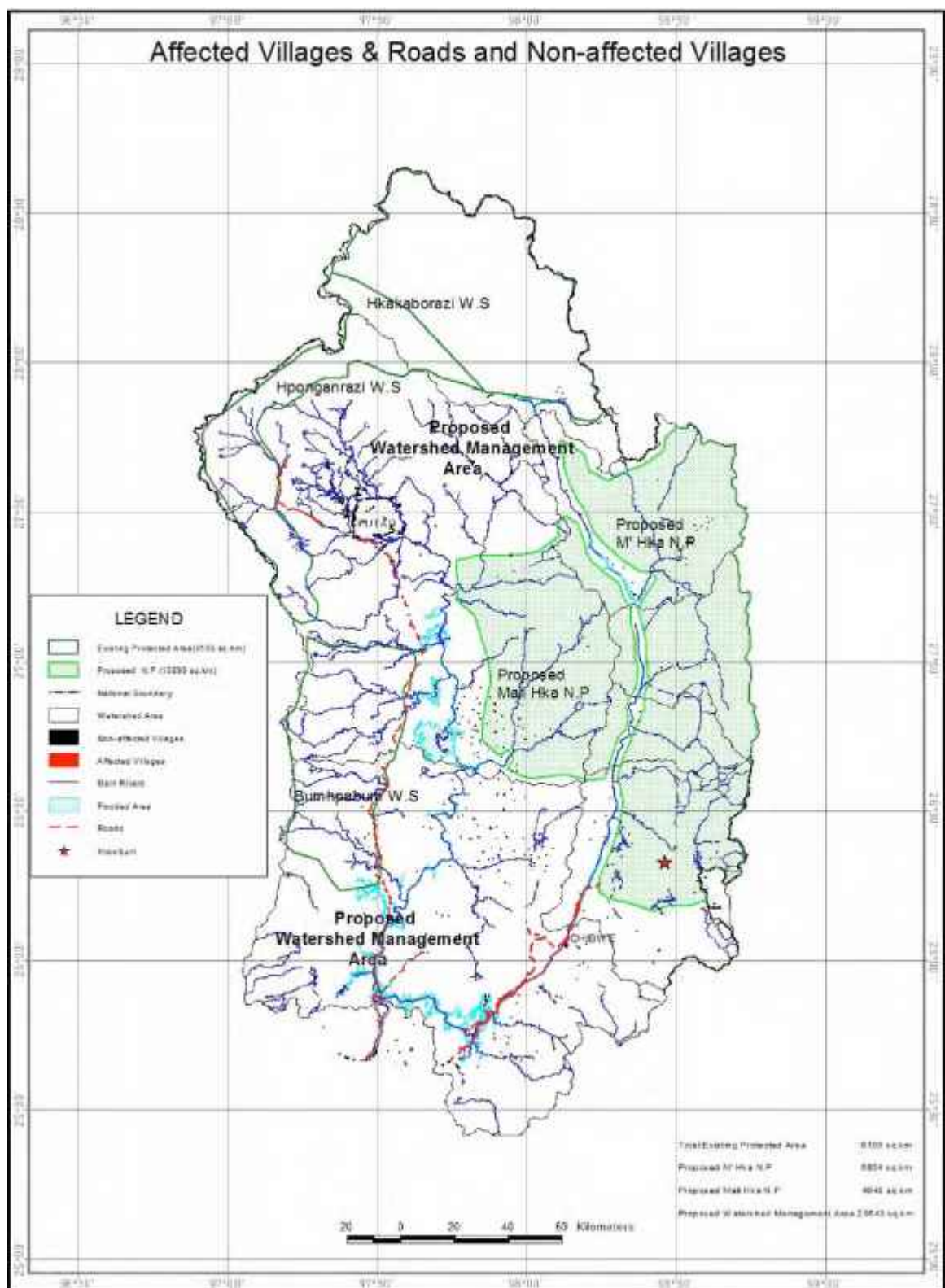


Fig. 3. Affected villages & roads and Non- affected villages

Prioritized Action 4

Regarding impacts on forests within the hydropower development area, funds will be provided to reforest and rehabilitate priority sites that have been degraded due to past commercial logging and shifting cultivation. Logging and clearing of the flooded areas will be contracted to logging companies through tendering. Detailed schedules and obligations of the contractor will be clearly specified in the contractual documents including delineation of reservoir areas and minimum logging and control over logging activities.

Prioritized Action 5

Many of the same measures will also ensure that wildlife is not exploited during dam construction period. In addition, the contractor will be held responsible for wildlife poaching by laborers. If a laborer is found in possession of wildlife species or other protected forest products, the contractor will be fined according to existing Myanmar law and the laborer will be dismissed; the same will apply to Project staff.

A small capture and release program will be undertaken, if necessary, for mammals trapped by logging and clearing operations. A plan for such activities will be prepared by a competent scientific NGO with assistance from the protected area management personnel.

Prioritized Action 6

To prevent from severe deforestation for firewood, Chinese workers should bring in their own gas stoves from China to the project areas. Serious regulation on hunting should be enforced. Community developments paying special attention to livestock breeding should be started as soon as possible. They should be in place before the constructions start.

11. POTENTIAL IMPACTS ON AQUATIC ECOLOGY & FISHERIES AND WATER QUALITY

An aquatic ecosystem is always firstly affected or disturbed on account of a dam construction. There should be adequate mitigating measures. Upstream of the dam, the habitat will change from free flowing to impounded water. The change in hydrological conditions will affect resident species that are unable to adapt to impounded conditions. Immediately downstream of the dam, the year round flow will be similar to conditions during the height of the dry season, and so will be less favorable to fish. Some species may be lost from the upper stretches of the rivers and the populations of other species may decline. Subsistence fishing is carried out in both upstream and downstream of the rivers and commercial fishing was not reported in the project villages, though some villagers occasionally sell their catch at local markets.

Huge amount of cubic meters of excavation will be required during dam construction and there will be serious erosions if proper engineering is not undertaken. A major short-term water quality issue is related to the flooding of forests. If not cleared, the drowned organic matter will decay during the first few years after impoundment and could result in the release of anoxic waters that are lethal for fish and aquatic animals. During construction there will be potential water quality impacts from washings from production of concrete, fuel, and oil, and from wastes generated at the camps.

During project construction, water pollution control measures such as appropriate siting of fuel storage, intercepting and treating of gravel washings, and provision of sanitation measures at the camps will be done. These measures will be attached to the contractor's documents as contractual obligations.

Prioritized Action 2

In the first year of dam construction period, migratory fish species from downstream and upstream will aggregate along the dam construction sites. Local people can catch these aggregates easily. The prioritized action must be banning or prohibition of fishing of these species. Then, these fish aggregates will have to be captured and released back at suitable places along the river. A small capture and release program will be undertaken, for migratory fish aggregates at both downstream and upstream of dam construction sites. A plan for such activities will be prepared by a competent scientific NGO with assistance from the government fishery management personnel. Fish passages should be integrated into dam design from the start. There should have fish ladders and fish passage accessories for migratory fishes.

12. POTENTIAL IMPACTS ON LIVELIHOODS, PUBLIC HEALTH & SAFETY

According to our GIS map analysis; altogether 51 villages shall be flooded on account of construction of a series of dams in Kachin State. Proper resettlement program must be a priority.

Main health risks during the construction stage are linked to (i) inadequate sanitation facilities in worker camps; (ii) introduction of new diseases, by immigrant workers; (iii) outbreaks of malaria in the labor force; and (iv) inadequate health services in the Project area. Measures will aim to secure public health and safety among the workers and nearby population through preventive actions and adequate facilities. The long-term, or operation phase, measures will aim to improve the general health status of the population in the region, with special attention given to potential risks concerning development of water- related diseases because of changes in the river system.

Additionally, the Project will support a public health improvement program based on the control of malaria in the Project area and the improvement of local health facilities.

Prioritized Action 1

Proper social impact assessment must be done before construction of each dam to know real impacts on livelihoods of the poor people living there. Proper resettlement program must be given the highest priority.

Prioritized Action 2

The following set of actions will be undertaken at the labor camps: (i) pre-employment medical screening and treatment of workers if required, (ii) control of importation of diseases in the camps through regular checkups, (iii) implementation of safety regulations and facilities on construction sites, and (iv) a malaria control program to reduce the risk of a malaria outbreak, through health education and provision of bed nets. The contractor will be required to prepare a health and safety plan in his Environmental Management Program.

A health education program, covering malaria, hygiene, and sexually transmitted diseases will be implemented. This task will be carried out by a competent non government organization under the supervision of the Ministry of Health. Because of the probable temporary influx of people into the project sites the Project will construct a health center which will be supplied with appropriate equipment and an adequate supply of drugs, as listed in the World Health Organization's "Essential Drug List."

13. TRANS-BOUNDARY WILDLIFE AND TIMBER TRADE

This report aims to highlight wildlife trade trends in threatened and at-risk wildlife species. Recent overexploitation of wildlife for trade has affected countless species, with elephants for ivory one of the most-well known examples. It also looks at the expanding international trade in Chinese traditional medicines. Our current Myanmar traditional medicines dated back to many centuries. One source said that both Chinese and Vietnamese traditional medicines have been thousands of years old (TRAFFIC 2008). Over-utilization along with habitat loss has impacted and shrunk medicinal plant and animal populations, now considered endangered. Plant resources have been degraded due to lack of scientific standards and methods for sustainable collection. Secondly driven by market demand, many wild medicinal plants have been collected beyond their regenerative capacity. This over-collection paired with habitat loss, leads to sharp decline or even to local extinctions of some species, particularly those that cannot be cultivated. The wildlife meat trade is also included in this report. Freshwater turtles and snake species are common, including Box Turtle (*Cuora amboinensis*), Elongated Tortoise (*Indotestudo elongata*), both are CITES II- listed species and classified as Vulnerable on IUCN Red list. Species from Myanmar (Burmese Eyed Turtle *Morenia ocellata* and Burmese Flapshell Turtle *Lissemys scutata* were common in markets in 1995, but absent by 2000, suggesting that the trade in wild-caught food turtles is unsustainable (TRAFFIC 2007A). The large turtles and Myanmar species may well no longer be available. Illegal trade of pangolin is also common. According to one source, in Myanmar, a pangolin costs RMB20/kg (USD3/kg). When smuggled to Kunming Province, China, the price rises to RMB400/kg (USD57/kg). Upon arrival at Guangdong province, the price goes up to RMB600/kg (USD171/kg) at special times such as just before Chinese New Year (TRAFFIC 2007). However this current study shows the price of a pangolin (skin with scales) in Myanmar has been USD 60/kg. During this study our wildlife trade monitoring team has observed wildlife parts such as heads of gibbons, bills of hornbill, skins and molar teeth of elephants, bones of cat species, oil, skull, canine and gallbladder of bear, horns and antlers of various wildlife species. Resolving illegal wildlife trade is impossible unless consumers are brought into due considerations. They should be regarded as our partners. Understanding the motivations of people in various parts of China for consuming wildlife foods and tonics is very important and long-term communication campaigns will reduce China's consumption of illegally traded and unsustainably produced wildlife products (TRAFFIC 2007). Regarding major wildlife trade routes, Makonkhen, Kangfang, Hpimaw, Pangwa, laiza, kambaiti, Lweje and Muse are exit points from Myanmar to China. A total of 28 wildlife species were recorded during this impact study and 25 species were listed as globally threatened according to IUCN Red List (see the detail in Part III which also shows traded wildlife species, prices and their conservation status).

Wildlife trade is big business, worth billions of dollars involving for example, some 88 million orchids, 6.2 million wild-caught live birds, and 7.5 million live-caught reptiles were traded globally between 1996 and 2001 (TRAFFIC 2007). Illegal and

unsustainable wildlife trade not only affects the species being exploited. It also directly affects the livelihoods of millions of people- especially the world's poorest, who depend on local wild animals for meat and on local trees and plants for fuel and medicine. Illegal trade also undermines countries' efforts to protect and sustainably manage their natural resources.

Another area of trans-boundary wildlife trade is wood imports from Myanmar to China. China's demand for timber is growing each year. Unable to meet this demand from domestic wood resources since its 1998 logging ban, China has witnessed a rapid growth in timber imports and is now the second largest wood importer in the world (TRAFFIC 2007). Forests are essential to the long-term well being of our local populations, Myanma economy, and the regional biosphere as a whole. The 1992 UN Conference on Environment and Development (UNCED) recognized the importance of sustainability managing all types of forests in order to meet the needs of present and future generations.



Fig. 4. Wildlife trade at Laisa



Fig. 5. Wildlife trade at Laisa



Fig. 6. Wildlife trade at Laisa

Prioritized Action 1

Regarding the illegal trade of wildlife and forest products along trans-boundary, both China and Myanmar should abide by the UNCED Forest Principles and Agenda 21, and relevant UN conventions on biodiversity (such as CBD and CITES), climate change and desertification. Both countries should join regional cooperation to combat illegal logging following options for ASEAN and the East Asia Region (Brack 2006) and IUCN's initiatives of FLEG - Forest Law Enforcement and Governance (IUCN 2006).

Prioritized Action 2

Both countries should cooperate with TRAFFIC. TRAFFIC, the wildlife trade monitoring network recommends: supporting enforcement of CITES, the international convention that regulates international trade in wildlife, by promoting the inclusion of new species in the CITES appendices, by encouraging participation in CITES and keeping CITES strong ; tightening and enforcing legislation, by keeping countries comply with CITES regulations, running training workshops for customs officers, border police, nature conservation officials, to give them appropriate skills and tools to comply with and enforce wildlife trade laws including identification guides to recognize both legal and illegal species in trade; helping with anti-poaching efforts; and encouraging cross-border cooperation; discouraging purchase of wildlife goods such as products from endangered species; and working with local communities by providing practical help to overcome poverty and helping them use their local wildlife in a sustainable way.

14. BACKGROUND OF HYDROPOWER DEVELOPMENT IN KACHIN STATE

In recent years, according to developing need of national economy and society, the government of Myanmar gives priority to hydropower development and encourages and introduces foreign enterprises to exploit abundant water resources of Myanmar. As the largest river of Myanmar, Ayeyawady River flows from the northern part to the southern part. It is endowed with the richest hydropower resources. The hydroenergy of Ayeyawady River is mainly distributed in the basin above Myitkyina. The theoretical reserves of hydroenergy is about 18,540 MW and the total energy is approximately 162.4 billion kW.h. It has a high development value.

In December 2006, China Power Investment Corporation (CPI) and Myanmar Ministry (1) of Electrical Power signed the Letter of Intent for Hydropower Development on Ayeyawady River Basin above Myitkyina, Kachin State. According to requirements of the Entrusting Letter to Undertake the Preparatory Work for the Myanmar Hydropower Project CPI South Branch, Changjiang Institute of Survey, Planning, Design & Research (CISPDR) will undertake the hydropower development and utilization planning in the Ayeyawady Basin above Myitkyina, Myanmar.

According to basin characteristics of Ayeyawady River above Myitkyina and the requirement of national economy development in Myanmar on river exploitation, the tasks of basin development are for power generation and, concurrently, for flood control. After the completion of cascade power stations, it can fully meet the requirements of national economy development of Myanmar on power and can export large amount electricity to neighboring countries to obtain great economical returns. Therefore, the main task of development of Ayeyawady River above Myitkyina is power generation.

14.1. Power Generation

The water resources of mainstream of Ayeyawady River are concentrated in section above Myitkyina. Since Mayhka River and Malihka River feature high drop and large water flow, there are abundant water resources among which Malihka River has the richest water resource.

By estimation, Mayhka River spans approximately 353 km within Myanmar with a drop of 1,010m and an average gradient of 2.9%. theoretically, its power of hydroenergy reserves is 12,200 MW and the total energy is 106.9 billion kW.h. Malihka River spans approximately 375 km within Myanmar with a drop of 4,470m. The average gradients of the river above Man Nansai and the section downstream Man Nsai are 62% and 0.9% respectively. Theoretically, its power of hydroenergy reserves is 6,150 MW and the total energy is 53.9 billion kW.h. The total power of hydroenergy reserves of the basin above Myitkyina is approximately 18,540 MW and the total energy is approximately 162.4 billion kW.h.

14.2. Originally Recommended Hydropower Development Scheme

7 cascade hydropower stations are to be built in the hydropower development scheme of the Ayeyawady River Basin above Myitkyina, among which 5 cascade power stations are built on Mayhka River, one power station is built on Malihka River, and one is built 5km downstream the confluence mouth of the two rivers.

The hydropower development scheme for Ayeyawady River Basin above Myitkyina, recommended in this project are as follow:

Mayhka River: Yenam (1010m); Kawanglanghpu (875m); Pisa (665m);

Wutsok (525m); Chibwe (400m)

Malihka River: Lasa (370m)

Ayeyawady River: Myitsone (230m)

The total installed capacity of basin cascade development of Ayeyawady River above Myitkyina is 16500MW, with total power generation, 90.85 billion kW.h.

15. SERIES OF DAMS IN KACHIN STATE

Table 2. Reservoir Surface Area & Watershed area

No	Dams	Installed capacity (MW)	Reservoir area	Watershed area	Hectare/MW
1	Myitson	4100	64784 acres/ 26238 ha	11680 km ²	
2	Lasa	1900	60627 acres/ 24554 ha	15390 km ²	
3	Khaunglanghpu	2700	5948 acres/ 2409 ha	3455 km ²	
4	Yenam	1200	2265 acres/ 917 ha	5255 km ²	
5	Pisa	2000	1703 acres/ 690 ha	1950 km ²	
6	Wusok	1800	1229 acres/ 498 ha	1203 km ²	
7	Chibwe	2800	7935 acres/ 3214 ha	3796 km ²	
	Total	16500	144450 acres/ 58502 ha	42729 km ²	8.7 acres/MW i.e less than 3.5 ha/MW

Considering the reservoir surface area per MW, 3.5 ha/MW is acceptable in relation to international norm. However effective watershed management is essential. As immediate compensatory measures, systematic watershed management in Kachin State above Myitkyina and establishment of new Mayhka and Malihka national parks have been recommended above as prioritized actions to be taken.

Districts and Townships (flooded areas of dams)

1. Myikyina District

- Myikyina township
- Winemaw township
- Ingyanyan township
- Chibwe township
- Tsaw Law

2. Putao District

- Putao township
- Machanbaw township
- Sumprabum township
- Khaunglanhpu township
- Naungmon township

15.1. Myitsone hydropower project

15.1.1. General information

Flooded area and watershed area

The Myitsone Hydropower Dam project area is located between 25°40' N, 97° 20'E and 26°50' N, 98° 47'E and dam site is about 26/30 kilometres away from Myitkyina, Kachin State. The coverage annual rainfall at Myitsone (Tanphaye'village) is 100 inches and the annual flow of water into the dam is expected to be about 4540 m³/s. The areas along on both sides of the Mayhka and Malihka Rivers will be inundated and some of the vital habitats of diverse wildlife species will be lost forever.

The largest plains are around the confluence and Sha-ngaw village. These flood plains are the places where villages like Tang Phe, Tianzup, Man Waing, Seinihku, Shangaw, Mantong, Hka War Yang, Ma Jang Yan, Nget Pyaw Daw villages etc are situated. Most of the population living in these villages are a mixture of Jingpaw, Lauwaw, Lacheik, Rawan and Lisu.

The area flooded will be 26238 hactare. That is, the reservoir area of Myitsone is 26238 hactare. This will include most of the area lower than 230 meters above sea level. The total watershed area of Myitsone is 11680 sq-km, covering the huge area of Mayhka and Malihka watersheds comprising intact forests.

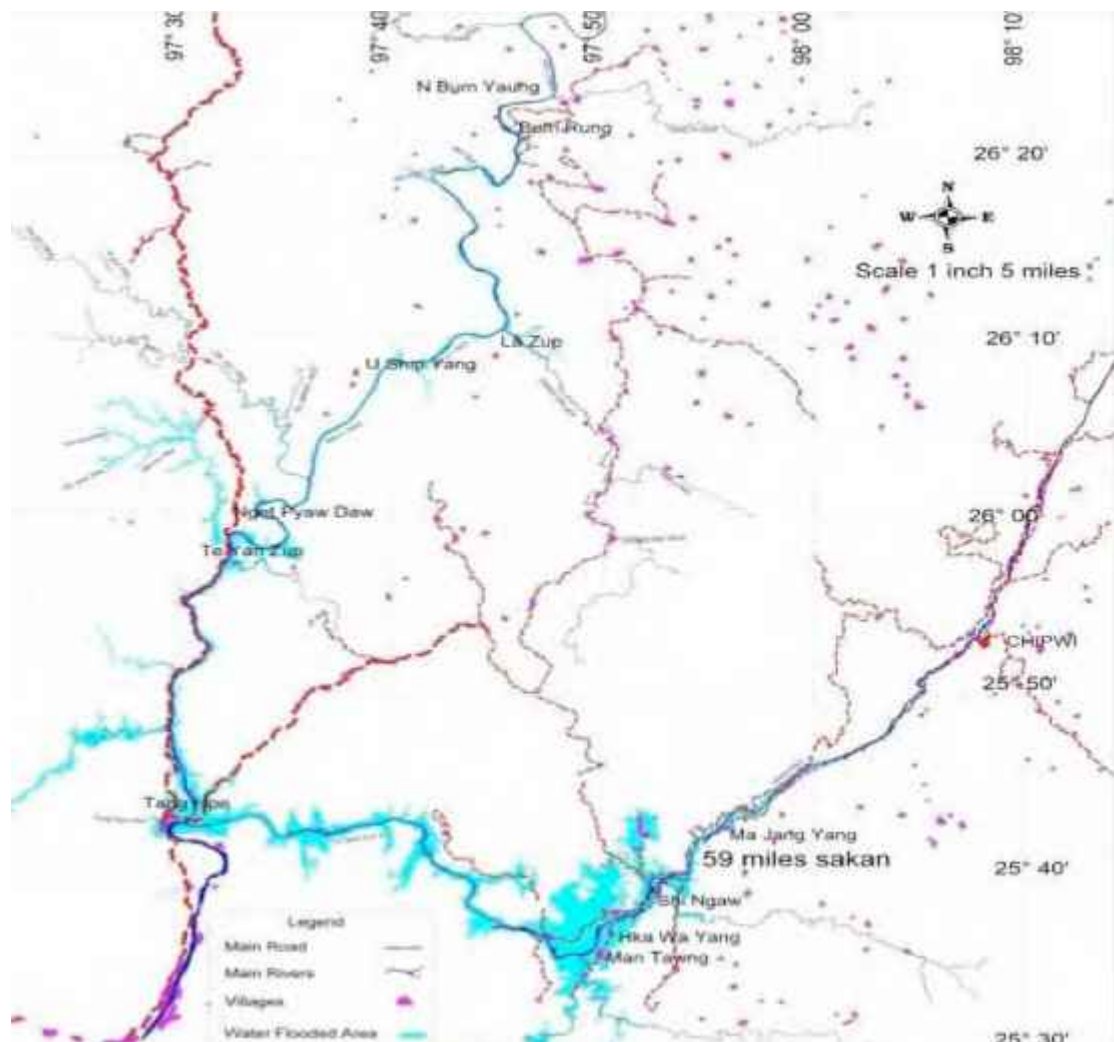


Fig. 7. Myitsone hydropower project

One section of road to Putao from Myitkyina i.e from Tang Pe to Tiangzup approximately 48 kilometres will be submerged. Similarly a section of Myikyina - Chibwe road about 64 kilometres will also be submerged.

The 59th mile bridge, Sha Ngaw Bridge on the way from Myikyina to Chibwe, Inzup Bridge, Tianzup Bridge and some small bridges on the road from Myitkyina to Putao will be flooded.

Thorough social impact assessment is essential here to clarify on negative social impacts. The 3,600 MW dam at the Myitsone, where the Malihka and Mayhka join to become the Ayeyaawady, according to one source, will inundate 47 villages, and enhance existing problems such as environmental and social impacts.

According to another source of reliable local information, if Myitsone Dam were built, 5,000 houses from 30 villages will be sunk and 8,000 people will become homeless. Additionally, 18,000 arable acres, forests and natural resources will be submerged. The dam will destroy the Mali-M'mai confluence, which is regarded as the Kachin cultural heartland.

5.1.2. Vegetation, habitats and endangered species

Most of the areas flooded are bamboo and secondary forest, shifting cultivation, waste land, orange orchards, grassland, heavily logged forests and gold mines. Some areas of primary forests are found in this flooded area. Good quality primary forests exist only above 500 meters above mean sea level.

From biodiversity point of view, the project area lies in WWF Eco-regions of Mizoram-Manipur-Kachin Moist Evergreen Forest. The whole Kachin state lies in three WWF Eco-regions namely, East Himalayan Alpine Shrub/Meadow, Mizoram-Manipur-Kachin Moist Evergreen Forests, and Northern Triangle Temperate Forest. The Kachin State is also located within two priority corridor, namely Northern Mountain Forest Complex and Upper Chindwin Lowlands for conservation investment in Myanmar (Tordoff *et al.* 2005). This large conservation area in Kachin State is one of the biodiversity hotspots and is nationally important, regionally significant and globally outstanding. The project areas include low land evergreen forest, low land secondary forest, Oak forest, Bamboo forest and Banana forest.

According to the IUCN Red list (2000), the following plant species are recorded

- | | |
|---|-------|
| 1. <i>Aquilaria malacensis</i> Lam., | VU |
| 2. <i>Dipterocarpus turbinatus</i> Gaertn. f. | CR |
| 3. <i>Holarrhena pubescens</i> Wall. ex G.Don | EX |
| 4. <i>Shorea assamica</i> Dyer, | CR |
| 5. <i>Caesalpinia sappan</i> L. | CR |
| 6. <i>Dipterocarpus boudii</i> Koth. | CR |
| 7. <i>Taiwania cryptomeriodes</i> Hyata | VU |
| 8. <i>Caesalpinia sappan</i> L. | LR/LC |

According to the IUCN Red list (2009), the following fauna species are recorded;

1. Chinese pangolin	<i>Manis pentadactyla</i>	EN
2. Bengal slow loris	<i>Nycticebus bengalensis</i>	VU
3. Stump-tailed macaque	<i>Macaca arctoides</i>	VU
4. Shortridge's langur	<i>Trachypithecus shortridgei</i>	EN
5. Eastern hoolock gibbon	<i>Hoolock leuconedys</i>	VU
6. Dhole	<i>Cuon alpinus</i>	EN
7. Asiatic black bear	<i>Ursus thibetanus</i>	VU
8. Sum bear	<i>Helarctos malayanus</i>	VU
9. Clouted leopard	<i>Neofelis nebulosa</i>	VU
10. Asian elephant	<i>Elephas maximus</i>	EN
11. Gaur	<i>Bos gaurus</i>	VU
12. Yunnan spiny frog	<i>Paa yunnanensis</i>	EN
13. Keeled box turtle	<i>Pyxidea mouhotii</i>	EN
14. Myanmar roofed turtle	<i>Kachuga trivittata</i>	EN
15. Rufous-necked Hornbill	<i>Aceros nipalensis</i>	VU

15.1.3. Navigation

Both rivers are navigable to a certain length. The Malihka river is navigable upto Maliyan village which is situated approximately 15 miles east of Sumprabum. Maliyan would be in the flooded area of Lasa dam. There are about a dozen rapids along the river way which indicates the requirement of strong and powerful engines to get through. But above Maliyan, the currents of the rapids become too strong and navigation by any type of boat is impossible and not advisable.

Navigation on Mayhka is also risky. There are about 10 rapids along the river from the Myitsone confluence to the confluence of Tong Pan Hka. Above that the current becomes too strong for navigation.

Name of flooded villages

According to our GIS map analysis, the following villages will be flooded.

Tang Hpe; Te Yan Zup; Naing Sein; Nget Pyaw Daw; Zup Ra Yang; Sa ni to yang; Kwin Htau; Tang Bauk Yang; The waing; N Bum Yaung; U Ship Yang; Bum Rung; La Zup; Hkam Be Yang; Bum Lai; N Dawng Yang; Daw Man Yang; Ma Jang Yang; Ka Pyi Kawng; Kh Wa Yang; Tum Pang; Ma Li Yang; Au Ra Yang; U Laung Yang; Man Tawng; Shi Ngaw; Brm Ba; N Sawp Zup; N Jip; Hkat Pwa Hmaw; Zai ro (Za ru).

Proper Social Impact Assessment and Economic Impact Assessment must be done to have a full EIA of the area.

15.1.4. Gold mines and adverse impacts

There are numerous gold mines along both rivers, severely impacting the river environment. But the mines on the Malihka are bigger in scale and are very destructive to the river. Tianzup village is the place where most mines are situated, resulting in, the colour of water in the Malihka changes from clear to extremely turbid reddish brown. These mining activities will certainly increase the sedimentation of Malihka river dramatically, shortening the life span of the dams. Many types of mining are observed, starting from small scale gold panning to hydraulic mining on the banks of the rivers.

A. Small scale digging and panning of gold

These are found everywhere in the Kachin State. The local people are using rudimentary tools and normally with few or no chemicals. Local people have been doing this practice since many generations ago. Earth or sand along the banks of rivers and streams are dug out and sieved on plastic netting. The residue on the sieve is then collected and panned by hand. This type of mining is least harmful to the natural surroundings.



Fig. 8. Small scale gold mining

B. Hydraulic mining

Hydraulic mining is one of the most common types of mining. About 50% of the mines are of this type. The mines are situated on the banks of the rivers and streams. Chinese made 25 HP pumps with pipes attached to them are used for this type of mining. One set of mine has at least one set of pump and a pipe. Some people use more powerful

engines like 100 or 200 HP Japanese engines with which they can host more powerfully and effectively.

On slopes along the river banks the earth is first blasted with water jet. Promising sites are selected by this way and once gold is traced the walls of the mines are hosed down with water. Rocks and wood which cannot be sucked by the pumps are removed by manual labour. The slime produced from the hosed banks is then sieved on fine plastic netting. By the end of the day, the sieved residue is panned and gold is separated using mercury. This type of mining operation is the most destructive to the environment. Sometimes river banks collapse, causing landslides and if the river is small the course of river channel changes. This type of mining produces large amount of hazardous mercury deposits.



Fig. 9. Hydraulic mining in Tianzup village



C. Gold mining under water (suction dredging)

This type of mining is also common along both rivers but more on Malihka. This is for miners who want to move freely along the river in search of the most promising sites for gold. The engines are of same quality as described above but they are mounted on big boats or bamboo rafts. A suction dredge is directed by divers along the bottom of the river bed. Earth or sand is sucked up and sieved and the gold panned out as previously described above.



Fig. 11 Suction dredging on the Mayhka

D. Gold mining by bucket dredges

According to reliable local information, these are usually owned by Chinese companies. Dredges with powerful engines are mounted on big boats or rafts. They use two engine heads and iron buckets which rotate on chains. The bottom of the river is cupped or dredged up with the iron buckets and then sieved and panned. This method of mining operation ruins the river beds and cause the river banks to collapse, which is extremely destructive to the environment. This is quite common on the Malihka river but a few is also seen on Mayhka.

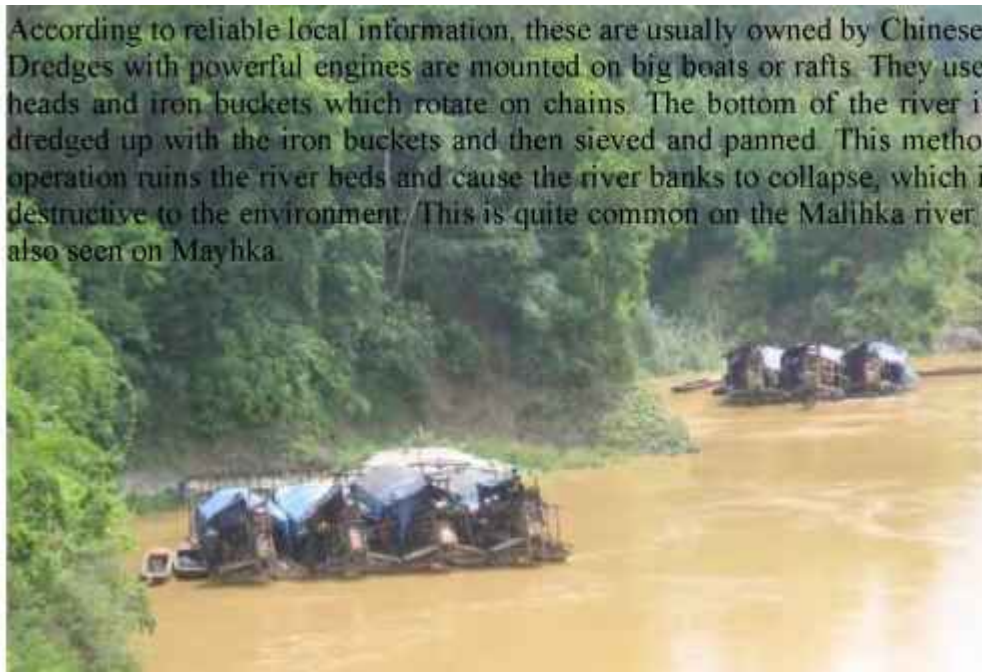


Fig. 12 Bucket dredges on the Malihka

Townships in the flooded area

1. Myitkyina
2. Ingyanyan
3. Chibwe
4. Sumprabum

15.1.5. Loss of cultural property

The confluence of Mayhka and Malihka river (called Myitsone in Myanmar) will be totally flooded on account of dam construction below the confluence. The Kachins take pride of possessing Myitsone on their land. They consider this confluence, their cultural heart land because it is the birth place of the mighty Ayeyawady River, the value of the latter knows no bound for the whole Myanmar people. Loss of Myitsone will be a terrible tragedy for all of Myanmar people especially the Kachins.

The majority people of local races oppose construction of the dams especially Myison hydropower project (S.Lashibauk pers comm.). They consider the Ayeyawady river confluence (Myitsone) as the cultural heartland of the Kachins. An alternative option should be seriously considered to avoid construction of Myitsone Dam at the confluence. The best option would be with experts' technical advice, to develop two smaller hydropower dams substituting Myitsone Dam location, at appropriate two locations above the confluence of Malihka and Mayhka rivers. Selecting and identifying two dam sites, above the confluence, one on the Mayhka River and another on the Malihka River shall avoid disappearance of the culturally very important site. Conducting social impact assessment is essential and the public should be disclosed about the hydropower dams and resettlement programs by having public meetings.

The dam site is located less than 100 kilometers from Myanmar's earthquake-prone Sagaing fault line. The highly sensitive Sagaing fault line runs north-south through Myanmar (Burma). Earthquakes have been experienced at places along the fault line. Dam breakage would be disastrous for Myitkyina, the capital city of Kachin State, which lies only 40 kilometers downstream. Formally and informally the people of Kachin State had already demanded the cessation of all dam activities in Kachin State. For the longevity of dams to be constructed in Kachin State, the opinion of the grassroots people should be brought into due consideration.

If Myanmar and Chinese sides were really concerned about environmental issues and aimed at sustainable development of the country, there is no need for such a big dam to be constructed at the confluence of Ayeyawady River. Instead two smaller dams could be built above Myitsone to produce nearly the same amount of electricity. Hence respecting the Kachin cultural values which surpass any amount of the overall construction costs.

15.2. Lasa hydropower project

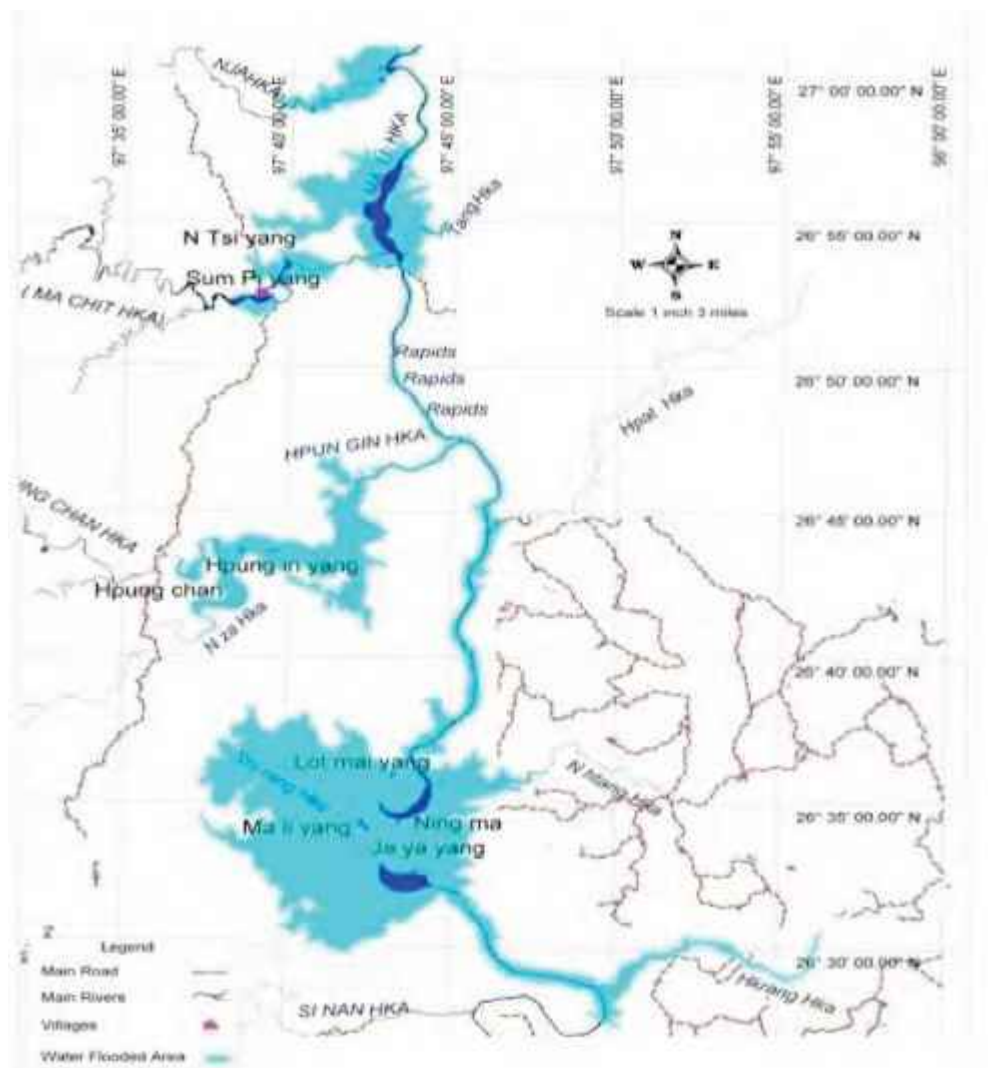


Fig. 13 Lasa hydropower project

15.2.1. General information

The Lasa Hydropower Dam project area is located at 26°28'N and 97° 49' E, in Sumprabum Township and 144.2 km distance to the confluence at Myitsone (The junction of Malihka and Mayhka). The flooded area of Lasa dam is 24554 hectare. The total watershed area of Lasa is 15390 sq-km. Geographically, most of the area is the flood plain of Malihka river. After construction of the dam there will be four pools in the reservoir area. The biggest pool will be in a place around Maliyan village which is situated east of Sumprabum town. The locals used to call that place Pinle, meaning 'sea' in Myanmar language. That place is known to be like a sea when there are floods.

The biggest villages inundated will be Sumpiyan village which has over 200 households and a population of approximately 1200. Most of them are Jingphaw. There are about 40 hectares of paddy fields which provide rice to Sumpiyan village and its surroundings. Those will also be flooded. Also flooded will be Phon- in and Nansiyan villages, each having less than 20 household.

Majority of ethnic tribes living in the flooded area is Jingphaw. Before the state government made a peace deal with the KIA, Sumprabum used to be the strong hold of KIA. At that time the majority of Jingphaw in the Kachin state lived in Sumprabum.

The name "Sumpra" means a species of long grass good for feeding horses and bum means a mountain. Therefore Sumprabum means a mountain where a species of long grass for feeding horse grows.

15.2.2. Vegetation, habitats and endangered species

In that area much of the land is covered with bamboos, grass lands, cultivated lands, paddy fields of Sumprabum Township, scrub forests and at the edges some disturbed primary forests. Most of the primary forests in this area have been previously logged on account of easy accessibility. Big patches of genuine primary forest are rarely found in the flooded area.

In 1977 there was an outburst of rats in Sumprabum. This was on account of gregarious bamboo flowering in the area. It was believed that the bamboo seeds contained a hormone which encouraged sexual activity in the rats resulting in outburst of rat population. All the crops in Sumprabum were destroyed and the town became unsuitable for human habitation. Starting from that time the majority of the Jingphaws migrated to Myitkyina.

From biodiversity point of view, the Lasa Dam area lies within WWF Eco-regions of Mizoram-Manipur-Kachin Moist Evergreen Forest and Northern Triangle Subtropical Forest-Myanmar. The catchment area of Chibwe Dam area is located in and between Hukaung Valley W.S and its extension and Bumphabum W.S. So the area as a whole is the biodiversity hotspot and outstanding area of conservation. The forest types are oak forest, lowland evergreen forest, highland evergreen forest and bamboo forest.

According to the IUCN Red list (2000), the following endangered plant species are recorded;

- | | |
|---|----|
| 1. <i>Aquilaria malacensis</i> Lam. | VU |
| 2. <i>Dipterocarpus turbinatus</i> Gaertn. f. | CR |
| 3. <i>Shorea assamia</i> Dyer | CR |

According to the IUCN Red list (2009), the following fauna species are recorded;

- | | | |
|---------------------|---------------------------|----|
| 1. Chinese pangolin | <i>Manis pentadactyla</i> | EN |
|---------------------|---------------------------|----|

2. Bengal slow loris	<i>Nycticebus bengalensis</i>	VU
3. Stump-tailed macaque	<i>Macaca arctoides</i>	VU
4. Shortridge's langur	<i>Trachypithecus shortridgei</i>	EN
5. Eastern hoolock gibbon	<i>Hoolock leuconedys</i>	VU
6. Dhole	<i>Cuon alpinus</i>	EN
7. Asiatic black bear	<i>Ursus thibetanus</i>	VU
8. Sum bear	<i>Helarctos malayanus</i>	VU
9. Clouted leopard	<i>Neofelis nebulosa</i>	VU
10. Asian elephant	<i>Elephas maximus</i>	EN
11. Gaur	<i>Bos gaurus</i>	VU
12. Yunnan spiny frog	<i>Paa yunnanensis</i>	EN
13. Keeled box turtle	<i>Pyxidea mouhotii</i>	EN
14. Giant Asian pond turtle	<i>Heosemys grandis</i>	VU
15. White-bellied Heron	<i>Ardea insignis</i>	CR
16. Rufous-necked Hornbill	<i>Aceros nipalensis</i>	VU
17. Pallas's Fish Eagle	<i>Haliaeetus leucoryphus</i>	VU

15.2.3. Gold mining and adverse impacts

Maliyan village used to be a major gold mining area during the last 15 years. Now less yield of gold and fewer discoveries of new mining sites elsewhere have made this place less occupied by miners. But the environment already damaged due to previous mines are quite evidenced everywhere.



Fig. 14. Gold mining: Water pollution caused by gold mining.

15.2.4. Navigation

From Myitkyina, Malihka is navigable till a few miles above Mayliyan village. After that the current in the rapids becomes very strong and the section of the river narrows down, making it impossible to navigate. Townships in the flooded area are Putao, Machanbaw and Ingyanyan.

The reservoir surface area of Lasa is 24554 hectare.

Name of flooded villages

According to our GIS map analysis, the following villages will be flooded.

N lwe yang; Yu sa ti; Sum pi yang; Hpa kan yang; Hpung in yang; Khin du yang; Ma li yang; Ja ya yang; Ning ma; N frung tu; Lot mai yang.

Proper Social Impact Assessment and Economic Impact Assessment must be done to have a full EIA of the area.

15.3. Chibwe hydropower project

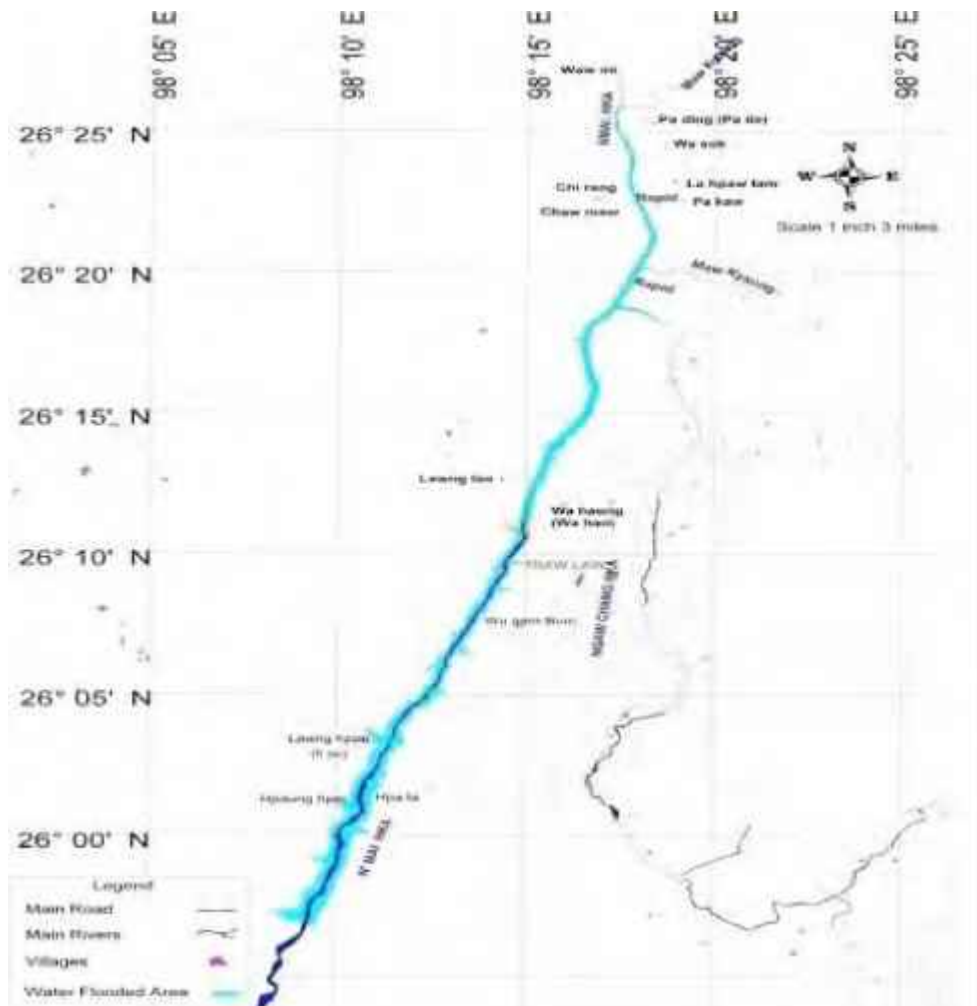


Fig. 15. Chibwe hydropower project

15.3.1. General information

The Chibwe Hydropower Dam project area is located on the downstream next to the Wusok Dam on the same river, Mayhka. It lies between 25°58'N and 98° 09' E and reaches about 20 kilometres upstream from the confluence of Mayhka River and Chibwe Stream near Mandon Village, in Chibwe Township. The flooded or the reservoir surface area will be 7935 acres. The total watershed area of Chibwe Dam is 3796 sq-km. An adit has been observed to build small Chebwe dam to generate essential electricity for forthcoming construction of Myitsone and Chebwe dams.

There are no flood plains in the reservoir area. The flooded area is situated in the deep gorges between two mountain ranges where the Mayhka river flows. Townships in the flooded area are Chibwe, Tsaw Law and Ingyanyan. Some villages like Kaunghla, Phala, Manton which have less than 15 households are situated in the reservoir area and thus will be inundated. Majority of ethnic tribes living there are Lauwaw and Lacheik.

15.3.2. Chibwe Township & Tsaw Law Township

Chibwe Nge Dam or Small Chebwe Dam near Chebwe is being built to supply power during construction period of dams in Kachin State. Population of Chibwe township is 17100 according to 2007 - 2008 figures by immigration department. Main economy is cultivation and collection of NTFPs. Major crops are paddy (both taungya and rain dependent) edible oil crops mainly mustard and sesame. Regarding with the agro-biodiversity, the rudimentary type of wild rice and their ancestors such as *Oirza officinales*, *O.rafipogon*, and *O.granulata* thrive very well at Chibwe, Tamu and Ngaw Chary Hku river valley. A trace of these progenitor rice varieties indicated that wild rice is indigenous to N.E Kachin and considered to be the original locations for world rice cultivation. In Ngaw Chan Hka river valley, about 100 varieties of wild rice ancestor based local land races have still been cultivated (Kalaya Lu 2006) and the following have been observed during this study;

1. *Oryza indicum* L. Cultivar Kauk - Nyin -Ni
2. *Oryza indicum* L. Cultivar Kauk - Kyan
3. *Oryza indicum* L. Cultivar Kauk - Nyin-Phyu
4. *Oryza indicum* L. Cultivar Kauk - Daung - Tit
5. *Oryza indicum* L. Cultivar Kauk - Nyin - Phyu
6. *Oryza indicum* L. Cultivar Khaw - Nar
7. *Oryza japonica* L. Cultivar Sat - Gar
8. *Oryza japonica* L. Cultivar Net - Paw - Kauk
9. *Oryza japonica* L. Cultivar Ja - Time
10. *Oryza japonica* L. Cultivar Kauk - Sar

The above native rice species and varieties were collected and identified and sample seeds were also kept in the herbarium.



Fig. 16. Charcoal bags in truckload in Chibwe Township



Fig. 17. A truckload of rattan in Chibwe Township

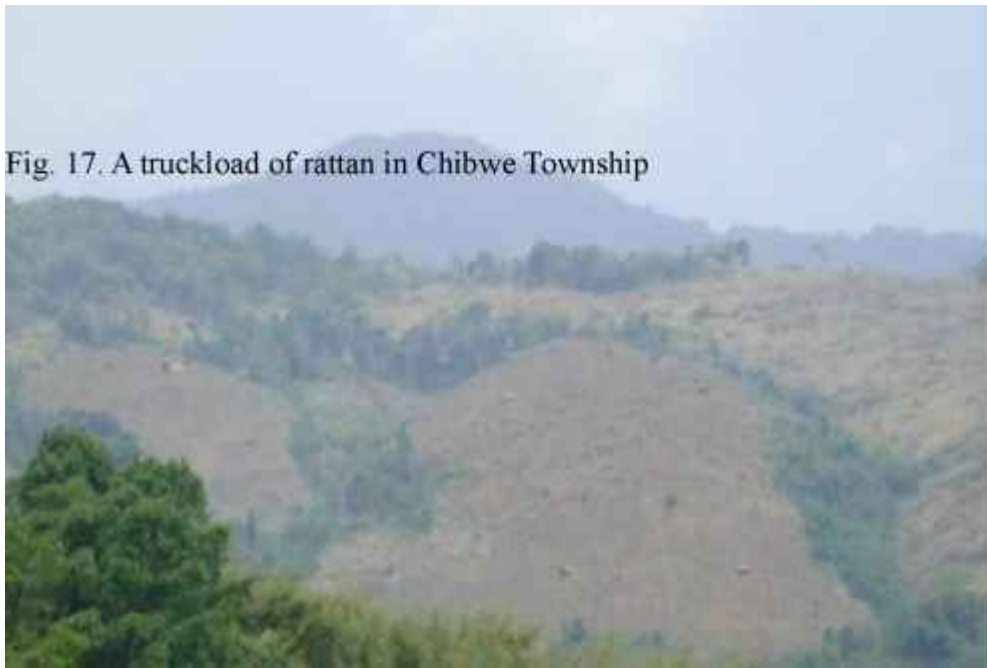


Fig. 18 . Shifting cultivation in Chibwe Township

A metal purifying industry is located inside China boundary between N 26' 06' 107" and E098'34'798". It is on the east bank of Ngaw-Chan-Kha river inside China boundary which is above upstream of Gur-lan Village inside Myanmar boundary. The water in upstream of Ngaw-Chan-Kha river above the metal purifying industry was clean and greenish blue in color. But the water in downstream become red and dirty due to the chemical waste disposal of metal purifying industry into the Ngaw-Chan-Kha river. (see photographs). During past 3 years due to chemical waste disposal from metal purifying industry, water in Ngw-Chan-Kha river, from Gar-lan village to the place where it drains into Mayhka river, about 113 kilometres, become red and polluted. Photographs will show the conspicuous difference between the clear water from the springs on both sides of the river flows into the red and dirty water of Ngaw-Chan-Kha and then red and dirty water of Ngaw-Chan-Kha flows into the clean water of Mayhka river. Photographs also shows the residues of waste products which deposit on the bank of the river when the water level in the river drops off. Tarong Wang and Ngaw-Chan-Kha are two transboundary rivers. Through negotiations, pollution control should be done at the downstream of the transboundary rivers between Yunan and Kachin State.

15.3.3. Vegetation, habitats and endangered species

Because vegetation in this area have to grow on steep slopes of more than 45 degrees it is impossible to find large areas of primary forest. Some patches less than 20 hectares of poor quality primary forests have been found on some slopes. Most of the forests in accessible areas are severely degraded due to prolong exploitation by both Myanmar and Chinese sides. But most of the vegetation in the reservoir area comprises shifting cultivations, secondary vegetation, a few river bank gardens and bamboo forests. No paddy fields are found here.

The project area lies in WWF Eco-regions of Mizoram-Manipur-Kachin Moist Evergreen Forest. The catchment area of Chibwe Dam includes Bumphabum W.S and Emawbum Mountain forest and is one of the outstanding hotspot areas for conservation. The forest types are highland evergreen forests, lowland evergreen forests, oak forests, bamboo forests, degraded forests, and low-land secondary forests.

According to the IUCN Res list (2003), the following plant species are recorded;

- | | |
|--|----|
| 1. <i>Cephalotaxus griffithii</i> Hook. f. | LR |
| 2. <i>Taiwania cryptomeriodes</i> Hayata | VU |

According to the IUCN Red list (2009), the following fauna species are recorded:

- | | | |
|---------------------|---------------------------|----|
| 1. Chinese pangolin | <i>Manis pentadactyla</i> | EN |
|---------------------|---------------------------|----|

2. Bengal slow loris	<i>Nycticebus bengalensis</i>	VU
3. Stamp-tailed macaque	<i>Macaca arctoides</i>	VU
4. Eastern hoolock gibbon	<i>Hoolock leuconedys</i>	VU
5. Asiatic black bear	<i>Ursus thibetanus</i>	VU
6. Red panda	<i>Ailurus fulgens</i>	VU
7. Marbled cat	<i>Pardofelis marmorata</i>	VU
8. Gaur	<i>Bos gaurus</i>	VU
9. Rufous-necked Hornbill	<i>Aceros nipalensis</i>	VU
10. Beautiful Nuthatch	<i>Sitta formosa</i>	VU

15.3.4. Navigation

Because of strong currents navigation is totally impossible in this section of Mayhka river.

Ecotourism potential with canoeing activities may be possible with the help of experts' advice.

Name of flooded villages

According to our GIS map analysis, the following villages will be flooded.

Hpala; Wang rong; Sum pi yang.

Proper Social Impact Assessment and Economic Impact Assessment must be done to have a full EIA of the area.

15.4. Yenam Hydropower project



Fig.19 Yenam Hydropower project

15.4.1. General information

The Yenam Hydropower Dam project area is located between 27°40'20"N, 97° 01'36"E and 27°48'18"N, 98° 08'97"E near Aliaung Village, in Panandim Township, on

downstream confluence mouth of Mayhka River and Tarone Stream. Among five hydropower stations on Mayhka River, Yenam Hydropower Dam site is on the upstream of Mayhka River and may be the first one on Mayhka River. The flooded area or reservoir surface area of Yenam dam will be 917 hectare. The total watershed area of Yenam is 5255 km².

The only village which will be flooded is Aliaung village. Recently gazetted Pannandim town is located above the full tank level and is spared from flooding. Ethnic tribes living there are Rawan, Lisu and Taron, which is also known as pygmies of northern Myanmar. The main administrative area in this area is Pannandim. It has been recently promoted to sub-township status from a village tract status. The population of Pannandim is 1670 according to 2008 immigration department figure. The main economy is Taungya cultivation. Major crops there are Taungya paddy, corn, maize and mustard. The reservoir area totally lies in Naungmon Township.

There is no primary forest in the flooded area. Storage water of the dam will be in deep gorges of the Namtamai valley and Taron river. Shifting cultivation, secondary vegetation, bamboo forest and river bank gardens will be the areas flooded.

15.4.2. Vegetation, habitats and endangered species

The northern boundary of the flooded area of this dam is also the southern boundary of Hkakaborazi National park. The flooded area does not have a huge impact on the national park because there are only very steep edges of the park with almost no primary vegetation. Forest types there are of evergreen, semi-evergreen in nature and are usually seen on higher elevations.

The Yenam Dam site lies in WWF Eco-region of Northern Triangle Temperate Forest. It is also located within the range of priority sites for conservation investment of Northern Mountain Forest Complex (BI 1995). Its catchment area also comprises Hkakaborazi N.P and Hponganrazi W.S. which are the biodiversity hot-spots and globally outstanding conservation areas. The forests in this area include high land evergreen forest and oak forest. Some degraded forests due to shifting cultivation are also found.



Fig. 20. Shifting cultivation

According to the IUCN Red list (2000), the following fauna species are recorded:

1. Chinese pangolin	<i>Manis pentadactyla</i>	EN
2. Stump-tailed macaque	<i>Macaca arctoides</i>	VU
3. Eastern hoolock gibbon	<i>Hoolock leuconedys</i>	VU
4. Dhole	<i>Cuon alpinus</i>	EN
5. Asiatic black bear	<i>Ursus thibetanus</i>	VU
6. Sum bear	<i>Helarctos malayanus</i>	VU
7. Red panda	<i>Ailurus fulgens</i>	VU
8. Marbled cat	<i>Pardofelis marmorata</i>	VU
9. Clouted leopard	<i>Neofelis nebulosa</i>	VU
10. Black muntjac(?)	<i>Muntiacus crinifrons(?)</i>	VU
11. Takin	<i>Budorcas taxicolor</i>	VU
12. Red goral	<i>Naemorhedus baileyi</i>	VU
13. Rufous-necked Hornbill	<i>Aceros nipalensis</i>	VU
14. Beautiful Nuthatch	<i>Sitta formosa</i>	VU

15.4.3. Navigation

Navigation is impossible in these rivers because the rivers flow through deep gorges with rocky outcrops and the current is extremely strong. Ecotourism potential including canoeing activities may be possible with the help of experts advice.

Name of flooded villages

According to our GIS map analysis, the following villages will be flooded

Ale aung; Mung dong; Htunggoirn; Gamgo.

Proper Social Impact Assessment and Economic Impact Assessment must be done to have a full EIA of the area.

15.5. Khaunglangphu hydropower project

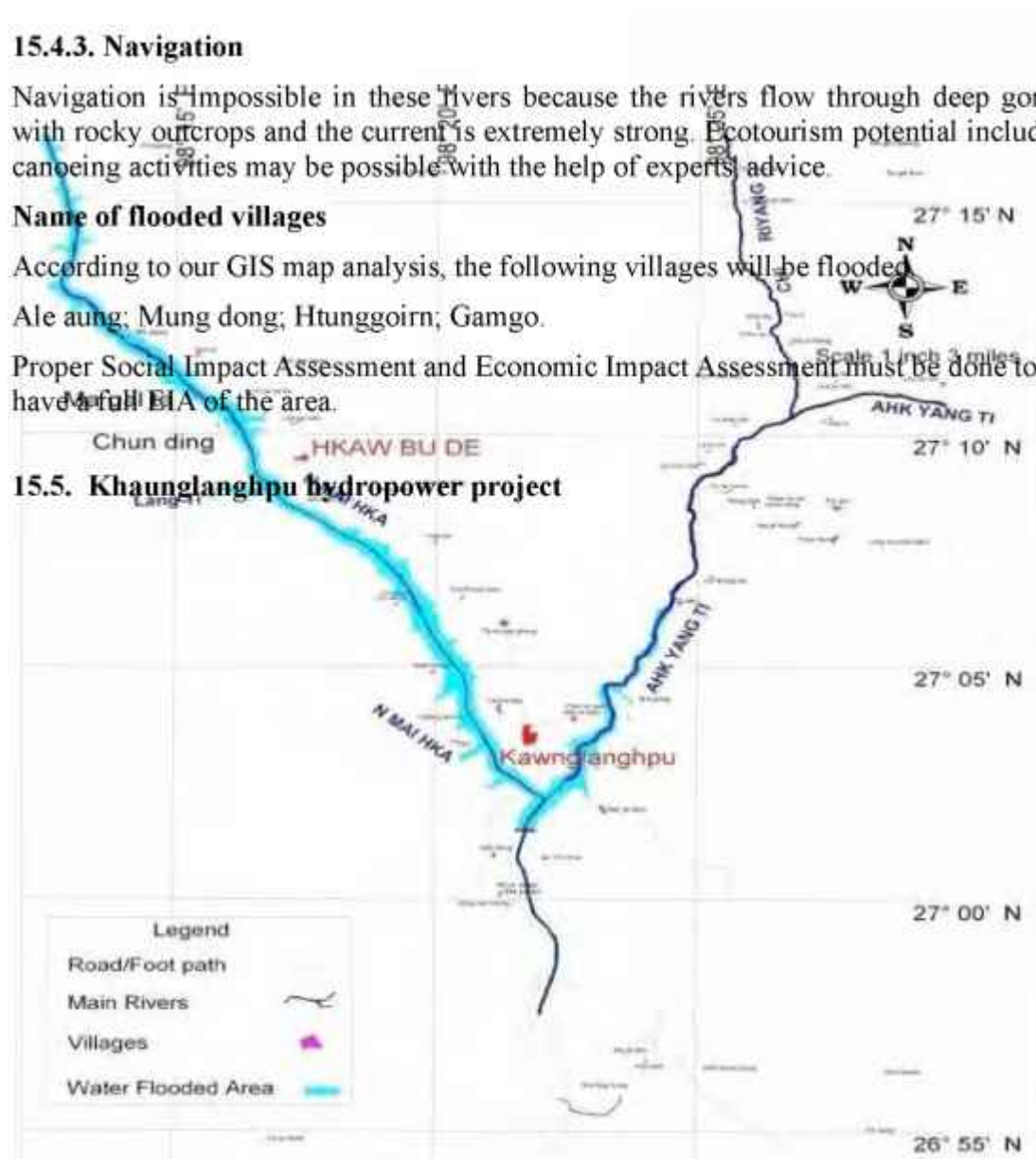


Fig. 21. Khaunglanghpu hydropower project

15.5.1. General information

The Khaunglanghpu Hydropower Dam project site is located between 26°30'N, 98° 00'E and 27°30'N, 98° 40'E near Sangn hkun Hkyet village, in Khaunglanghpu Township, on downstream confluence mouth of Mayhka River and Achanhti Stream. The dam site lies between high mountains and gorges. The elevation of Emawbum Mountain which comprises in the catchment area is 3100 m high.

The reservoir surface area of Kaunglanghpu dam is 5948 acres. The total watershed area of Kaunglanghpu is 3455 sq-km.

There are no primary forests in the reservoir area. Primary forests are only seen at high elevations. The flooded area lies totally in Khaunlanhpu Township. Ridam village and Ridam suspension bridge will be inundated. This should be compensated by all means. Local tribe living in Ridim are Rawans. Khaunglanghpu town is located at over 1462 metre and is free from flood. Ethnic tribes living in Khaunglanghpu are Rawan and Lisu. Because it is an administrative town, some Bamar national government staff also reside there. Population according to 2009 March census by immigration department is 19106.

Economy of Khaunlanhpu is mainly Taungya (shifting cultivation). Main crops are Taungya paddy, edible oil producing crops (mustard, sesame and groundnut) and corn. The main source of protein for the people is bush meat. But the hunters only hunt for daily subsistence and wildlife trading is rarely seen.



Fig. 22. Critically endangered species, *Schizothorax grahami* (Regan), recorded in Kaunglangphu Dam area.

15.5.2. Vegetation, habitats and endangered species

Primary forests are only seen at high elevations. Forest types there are of evergreen, semi-evergreen in nature and are usually seen on higher elevations.

The Khaunglangphu Hydropower Dam area lies in WWF Eco-region of Northern Triangle Temperate forest. It is also located within the priority site for conservation investment of Northern Mountain Forest Complex (BI 2005).

The Hkakaborizi NP, Hponganrazi W.S and Emawbum mountain forest lie in its catchment area. So the area is biodiversity hot-spot area and globally outstanding for conservation. The forest types are high land evergreen forest lowland evergreen forest and oak forest.

The critically endangered freshwater fish species, *Schizothorax grahami* (Regan) has been recorded in Kaunglangphu Dam area during this study. According to IUCN Red list (2000) the following floral species is recorded:

- | | |
|--|----|
| 1. <i>Taiwania cryptomerioides</i> Hayata. | VU |
|--|----|

According to the IUCN Red list (2009), the following fauna species are recorded:

- | | | |
|----------------------------|-------------------------------|----|
| 1. Bengal slow loris | <i>Nycticebus bengalensis</i> | VU |
| 2. Stump-tailed macaque | <i>Macaca arctoides</i> | VU |
| 3. Dhole | <i>Cuon alpinus</i> | EN |
| 4. Asiatic black bear | <i>Ursus thibetanus</i> | VU |
| 5. Takin | <i>Budorcas taxicolor</i> | VU |
| 6. Xizhang warty treefrog | <i>Theloderma moloch</i> | VU |
| 7. Blyth's Tragopan | <i>Tragopan boythii</i> | VU |
| 8. Rufous-necked Hornbill | <i>Aceros nipalensis</i> | VU |
| 9. Beautiful Nuthatch | <i>Sitta formosa</i> | VU |
| 10. Snowy-throated Babbler | <i>Strachys oglei</i> | VU |
| 11. Kunming Snout Trout | <i>Schizothorax grahami</i> | CR |

15.5.3. Navigation

Fig. 23. Wusok and Pisa hydropower projects

15.6.1. General information

Both dams are situated in Tsawlaw Township. The Pisa Hydropower Dam project area is located on the stream next to the Wusok dam, lying between 26°44'N and 98° 22'E in Tsawlaw Township and about one kilometre downstream from the confluence of Mayhka River and Mekharam stream near one rapid of Mayhka River. The Wusok Dam lies between 26°31'N and 98° 18'E and about 34.5km distance from Pisa Dam. The total watershed area of Pisa and Wusok is 3153 km². The reservoir surface area of Pisa and Wusok is 1188 hectares.

Accessibility is extremely difficult to both dams. The only way to get there is on foot. The road from Myitkyina to Tsawlaw is motorable only in open or dry season. The very strong and tough 4 wheel drive vehicles are needed to reach Kyihtam village from Tsawlaw. The only mean from Kyihtam onwards to reach Wusok dam site is through walking only and may take 3 days. And from Wusok it takes 7 days to reach Pisa dam site.

There are no villages in the flooded area. The major ethnic tribe living there is Lauwaw. Lacheik are minorities in that area. Local communities rely on shifting cultivation to get their main source of carbohydrates. The main crop is Taungya paddy. Oil producing sesame, peanuts, corn, maize, and occasionally pluses and beans are grown in their slash and burn areas. Some of them earn their living by small scale wildlife trading with neighbouring China.

15.6.2. Vegetation, habitats and endangered species

Vegetation in the flooded area is mostly primary and undisturbed forests. As trees are growing on steep rocky slopes, the primary forests with stunted growth are found. Good quality undisturbed primary forests are only found on higher elevations.

The Pisa and Wusok Dams areas lie in two WWF Eco-regions of Northern Triangle Temperate Forest and Mizoram-Manipur-Kachin Moist Evergreen Forest. It is also located near the priority site for conservation investment of Northern Mountain Forest Complex. So the areas are the biodiversity hot-spot areas and globally outstanding for conservation. The forest types are highland evergreen forests, low land evergreen forests, oak forests, secondary degraded forests and bamboo forests.

According to the IUCN Red list (2009), the following fauna species are recorded;

1. Stump-tailed macaque	<i>Macaca arctoides</i>	VU
2. Shortridge's langur	<i>Trachypithecus shortridgei</i>	EN
3. Eastern hoolock gibbon	<i>Hoolock leuconedys</i>	VU
4. Asiatic black bear	<i>Ursus thibetanus</i>	VU
5. Sum bear	<i>Helarctos malayanus</i>	VU
6. Marbled cat	<i>Pardofelis marmorata</i>	VU
7. Takin	<i>Budorcas taxicolor</i>	VU
8. Red panda	<i>Ailurus fulgens</i>	VU
9. Fishing cat	<i>Prionailurus viverrinus</i>	EN
10. Rufous-necked Hornbill	<i>Aceros nipalensis</i>	VU
11. Wood snipe	<i>Gallinago nemoricola</i>	VU
12. Beautiful Nuthatch	<i>Sitta Formosa</i>	VU

15.6.3. Navigation

Navigation in the river is impossible because of narrow sections with swift current and rocky outcrops. However ecotourism potential including canoeing activities may be possible with the help of experts' advice.



Fig. 24. Water pollution of Ngawchang Hka



Fig. 25. Illegal logging in Wusok area

16. RECOMMENDATIONS AND MITIGATING MEASURES

16. 1. Recommendations and Mitigating Measures (Policy Perspective)

Convince the decision makers of Myanmar to approve the drafted environmental law so that EIA practice becomes mandatory, prior major development programs, such as hydropower projects.

Develop hydropower resources in an economically viable and environmentally sound manner to support sustainable development efforts.

Apply high EIA standards. This should be done with long lead times, competent staff, open process, independent review and follow-up. As screening determines whether or not an individual project proposal requires a full-scale EIA and what the level of assessment should be, this current study (BIA) should be regarded as Preliminary EIA. More detail assessments and evaluations including social component should follow.

1. Conduct social impact assessments on small and large villages on account of constructions of dams in Kachin State.
2. As EIA is not mandatory in Myanmar, both parties must follow PRC (2003) Law on Appraising of Environment Impacts.
3. In addition to assessing both negative and positive aspects, scoping of EIA should aim at landscape scale level approach and river basin approach down to mouth of Ayeyawady River.
4. Follow Myanmar National Sustainable Development Strategy and Myanmar Biodiversity Strategy and Action Plan.
5. Enforce the 2006 Conservation of Water Resources and Rivers Law.
6. Follow suggestions towards dam construction extracted from working papers for WCD (App. 1)
7. Before decision making, decision makers must study both negative and positive aspects of dams (App. 2).
8. Before approval of dam construction, decision makers, investors and construction engineers must study the differences between bad and good dams and environmental threatening and environmental friendly dams (App. 3).
9. A fraction of hydropower revenues is to be used to improve conditions of affected people around the reservoir (WCD).
10. Abide by the obligations of international conventions such as CBD, CITES, etc.
11. Enforce the wildlife law effectively and if necessary, revise it to be in compliance with CITES regulations.
12. Monitor the illegal trade of forest and wildlife products regularly by government authorities, NGOs and detect changing trends and dynamics in trade and work closely in partnership with China.
13. Salvage or protection of cultural sites and properties.
14. Regarding Ngaw-Chan-Hka river pollution and to resolve this issue, there should be trans-boundary negotiations between China and Myanmar sides.
15. Create a financial mechanism to cover environmental costs during the project operation phase, that is, to pay for environmental management program implementation.

16. Consider to ban logging in Kachin State above Myitkyina.
17. Enhance partnership among the government, private sectors, and environmental NGOs to participate in environmental protection and sustainable resource management.
18. Resolve the complicated resource governance in Kachin State so that all the different parties or local authorities abide by the existing resource management laws of the country.

16.2. Recommendations and Mitigating Measures (Environmental Perspective)

1. Avoid areas of high biodiversity and hotspots.
2. Minimise species extinction.
3. Arrest continued loss of biodiversity.
4. Conserve essential ecological processes. Apply the precautionary principle when there is a threat of significant reduction or loss of biological diversity.
5. Resolve taxonomic and ecological information inadequacies that hamper conservation.
6. Guard unique species habitats in certain watersheds.
7. Give high priority to recovery of degraded ecosystems.
8. Avoid impacts on areas of high productivity of biological and economic importance.
9. Avoid areas of high biodiversity hotspots and species at risk should be brought into consideration during infrastructure development.
10. Avoid blocking short and long distance migrations.
11. Maintain the natural seasonal pattern of flow which is vital in life history stages such as migration, spawning and feeding.
12. Avoid blocking migratory fish species to avoid from extinction of genetically distinct stocks.
13. Do research and install devices for migrating species.
14. Integrate fish passages into dam design from the start.
15. Maintenance of at least minimum flow for fisheries.
16. Provision of fish ladders and other means of passage.
17. Protection of spawning grounds.
18. Should have fish ladders and fish passage accessories for migratory fishes.
19. Should have fish hatcheries for native fishes. in the suitable areas for restocking economically important indigenous fish species .
20. Establish reservoir fishery on cold water fish species in the hydropower development areas.
21. Design the project properly to reduce the impacts of this dam on aquatic and terrestrial biodiversity.

22. Maintain natural seasonal and daily river flow cycles. The natural seasonal pattern of flow is vital in life history stages such as migrations, spawning and feeding.
23. Sustain water quality. Appropriate temperature, oxygen, turbidity, and sediment levels are necessary for well-being of aquatic species. Pollution should be avoided.
24. Maintain discharge volume as much as possible.
25. Avoid cumulative effects of dams. There should be no more dams in close proximity.
26. Support to continue baseline studies on biodiversity. Knowledge on biodiversity is always incomplete. Reducing impacts on biodiversity calls for knowing where species, ecosystems and ecological functions are located. Lack of biodiversity information is a result of poor support for biological surveys and academic work on taxonomy and ecology. Comprehensive documentations of biological and ecological assessments are needed.
27. Regarding agro-biodiversity, carry out survey and research on wild rice varieties and their ancestors.
28. Ensure the current potential on availability of traditional medicinal plants.
29. Monitor impacts at old and new dams. One of the most serious information gaps is the lack of follow-up information on the environmental and biodiversity impacts following dam construction. Follow-up studies on dam impacts are required to plan for future environmental friendly dams.

16.3. Recommendations and Mitigating Measures (Social Perspective)

1. Launch social mobilization to convince people of the project benefits.
2. Construct dams with the consent of people living in the region.
3. Provide awareness to the locals about dam projects.
4. Should disclose to the public about the impacts and discuss with the locals and bargain on an income sharing basis.
5. Encourage self-reliance among the resettled population.
6. Compensate and provide employment to affected people if no land is available.
7. Ensure that affected villages sign contracts for compensation and resettlement.
8. Restrict the use of agricultural land for construction purposes as much as possible.
9. Develop systematic farming system towards permanent agriculture.
10. Restore the original living standards of the affected people.
11. Extend developmental assistance for up to ten years after resettlement implementation is completed.
12. Foster support for the affected people from the general population.
13. Include all compensation and resettlement costs in the project budget.
14. Ensure government approval of the land acquisition and resettlement plan.
15. Allow agricultural displaced people to resettle on land.

16. Enable urban affected people to choose houses in alternative locations or get cash compensation.
17. Promote livelihood inputs to relocated villagers of hydropower development area by using community forestry approach and agro-forestry practice. In addition to agricultural crops, suitable tree species are recommended for income generation.
18. Establish community forestry to provide NTFPs and develop sustainable alternatives to wood as a source of fuel.
19. Relocate people to suitable areas and provide compensation in kind for resources lost.
20. Avoid dislocation of un-aculturated people and where not possible, relocate in area allowing them to retain lifestyle and customs.
21. Provision of health and social services to resettled people.
22. Provide adequate health services, infrastructure, and employment opportunities.
23. Design and operation of dam to decrease habitat for vector and control of vector.
24. Maintenance of standard of living of resettled people by ensuring access to resources at least equaling those lost.

16.4. Recommendations and Mitigating Measures (Administrative & Technical Perspective)

1. Provide electricity coming out from this hydropower development to the people in Kachin State, some amount into national grid and surplus to export, thus enhancing MDGs.
2. Give the Kachin State Government overall responsibility for all resettlement.
3. Abide by Myanmar Forest Law, Wildlife Law and Mine Law.
4. Both parties should be encouraged to abide by the Chinese silvicultural guide for corporations importing timber to China from abroad.
5. As Mayhka River is being polluted on account of improper waste disposal at Ngaw Chang Hka River by adjoining country, negotiate with China side for proper waste disposal treatment.
6. Maintain discharge volume avoiding zero discharge except in very extreme emergencies.
7. Sustain water quality with appropriate temperatures, oxygen, turbidity and sediment levels for well-being or survival of aquatic species and pollution should be avoided.
8. Land use planning efforts in watershed areas above dams to avoid increased siltation and changes in water quality.
9. Increase of productivity or improve management of land (agricultural, range, forestry improvements) to accommodate higher population.
10. Take measures to minimize impacts and take precautions to minimize erosion.
11. Do careful locations of camps, buildings, borrow pits, quarries, spoil and disposal sites.
12. Do land reclamation
13. Choice of resettlement site to avoid surpassing carrying capacity of the land.

14. Protection of equal areas in region to offset losses. Creation of useable land in previously unsuitable areas to offset losses.
15. Control of land use in watershed (especially prevention of conversion of forests to agriculture).
16. Establish compensatory parks or reserved areas.
17. Reforestation and/or soil conservation activities in watersheds.
18. Control of land uses, wastewater discharges, and agricultural chemical use in watershed.
19. Do air and water pollution control.
20. Stop logging and harvesting of NFTP's in the watershed of this hydropower development.
21. Enforce laws to stop illegal activities including gold mining, hunting, trapping, logging and collection of non-timber forest products.
22. Manage sustainably reserved forests near and around the dam site and manage threatened plant species by allowing cultivation those in nearby reserved forests.
23. Introduce independent environmental audits to verify the level of compliance with environmental standards and efficiency of impact mitigation measures.
24. Mitigation entails the identification of ways in which negative impacts can be avoided or minimized to limit costs, and ways in which positive impacts can be enhanced to ensure maximum benefit.
25. A longer investigation time is strongly recommended in such a very big and sensitive hydropower development project which shall have very significant adverse impacts.
26. Continued monitoring is essential during and after construction of dams, and compensatory and remedial measures to be taken accordingly.

17. CONCLUSION : Toward Sustainable Development of Myanmar

The main drawback of this study of EIA Special Investigation on Hydropower Development of Ayeyawady River above Myitkyina, Kachin State, done by BANCA is lack of Social Impact Assessment. Before approval of this hydropower development in Kachin State, systematic social impact assessment must be carried out by competent social scientists.

Before approving the construction of a series of dams on Ayeyawady River above Myitkyina, Kachin State, the decision-makers are strongly urged to fairly balance between negative and positive aspects of dams (App. 2). The decision makers, developers, concerned engineers and dam designers are seriously advised to pay due consideration on the differences between bad and good dams and between environmental threatening and environmental friendly dams (App.3). The core construction engineers are also strongly urged to pay serious attention on the appended suggestions towards dam construction (App. 2).

The large expenditure involved with the construction and operation of large dams and the benefits for power generation are of considerable long-term economic importance of the country.(BANCA 2006). However the importance of economic and engineering paradigms in development alone cannot lead to sustainable development and economic prosperity. A better understanding of the interplay between development and natural

environment in which development takes place is necessary at the time of project planning to ensure environment security and economic prosperity of our country. (BANCA 2006). It becomes clear that sustainability has ecological, economic, and social dimensions, and only by accounting for all three can it be said that sustainability can truly be achieved. Also it is important to increase rural productivity in an environmentally friendly manner, which will generate income as a means for poverty reduction. Increasing public awareness about sustainable development is a matter of high priority.

Deforestation, loss of biodiversity, conversion of globally outstanding eco-regions, key biodiversity areas and the center of plant diversity into other land uses, soil erosion, water contamination and water-borne diseases, land clearance, excessive mineral extraction, improperly managed industrial effluents are environmental issues and causes, still found in Kachin State. There will be more environmental issues on account of a big scale hydropower development above Myitkyina. Resolving these issues, there should be an integration of environmental considerations and sustainable development concerns in national and sectoral development policies, planning and management processes. Also there is a need to enhance partnership among the government, private sectors, and environmental NGOs to participate in environmental protection and sustainable resource management.

When considering the question of impacts on ecosystems or biodiversity by large dams, all three dimensions of sustainability must be considered. Regarding Hydropower Development of Ayeyawady River above Myitkyina, Myanmar, proper selection of dam sites and proper dam designs can provide an acceptable environmental protection and at the same time can serve the country's desire for development. There must be a fair and equitable sharing of benefits coming out from this hydropower development among the stakeholders concerned, including the people of Myanmar in general and Kachin people in particular. Giving due considerations for effective implementation of prioritized actions, and by following mitigating measures along with recommendations, the hydropower development's adverse impacts can be kept to acceptable levels.

BANCA is always looking forward to seeing our country having a mechanism for combining economically sustainable growth with ecologically sustainable development.

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Appendix 1.

Suggestions towards dam construction (from working papers for WCD)

1. Recognize the important role of natural ecosystems in contributing to livelihoods and sustainable development.
 - a)** Assess the value of natural ecosystem functions and services during feasibility studies for both upstream and downstream communities. Water does not have a zero opportunity cost; **b)** Adopt a river basin approach to water and ecosystem management; **c)** Use multi-criteria decision-making that recognizes values other than costs and not simply a cost-benefit analysis; **d)** Rivers are a public trust and extractive use rights should not be permanently allocated; **e)** Identify users of the downstream and upstream natural resources and ensure that their needs are incorporated by the project .
2. Recognize the importance of biodiversity and promote its conservation.
 - a)** Ensure that dam projects comply with the provisions and guidance of the Convention on Biological Diversity, the Convention on Wetlands and other related nature conservation Conventions; **b)** Dams should not negatively impact any Red Data Book species; **c)** Dams should not be built in, nor should reservoirs impinge on, declared National Parks or Nature Reserves; **d)** Undertake comprehensive biodiversity surveys of rivers in order to allow the least ecosystem-damaging choices and trade-offs to be made. Ecological investigations should be placed on the same footing as engineering and economic assessments during project planning and not be .add-on. extras; **e)** River flows should not be reduced during commissioning to zero or levels likely to have a negative impact on biodiversity; **f)** Dams built on tributaries will have fewer impacts on migrating fish than those on the main stream.
3. Recognize and manage for uncertainty
 - a)** Recognizing that the precautionary principle should apply as it is at present impossible to predict all consequences of dam construction; **b)** Undertake baseline assessments of the riverine ecosystem and its biodiversity down to the river mouth, during feasibility studies to provide the information base needed to improve predictive capacity. **c)** Assess possible cumulative impacts.
4. Ensure effective participation in planning, design and management of dams.
 - a)** All EIA studies should be public documents; **b)** All stakeholders must participate in EIA and decision-making process. Utilize decision-making tools that Dams, Ecosystem Functions, and Environmental Restoration 88. This is a working paper prepared for the World Commission on Dams as part of its information gathering activities. The views, conclusions, and recommendations contained in the working paper are not to be taken to represent the views of the Commission encourage interdisciplinary discussion and stakeholder participation; **c)** Base decision-making on multi-criteria analyses, not simple cost-benefit analyses.
5. Maximize adaptive capacity. u Allow for regular monitoring of ecosystems to ensure that management objectives are met.
 - a)** Every existing dam should have an environmental flow requirement; **b)** Review operating rules every five years to incorporate findings of monitoring programs and mitigate unexpected ecosystem changes; **c)** Undertake research programs to solve outstanding problems; **d)** Ensure every dam has a proposal for how it will eventually be decommissioned, especially with regard to design features for reservoir drainage, the treatment of accumulated sediment, and appropriate financial measures for ecosystem restoration; **e)** Include direct revenue sharing

(hydropower), or environmental trust funds as tools to ensure funds for monitoring and repairing ecosystem damage are available throughout the project's lifetime.

Appendix 1. (continued)

Suggestions towards dam construction (from working papers for WCD)

6. Promote incorporation of environmental management features into dam design.
 - a)** Include biologists and ecologists in the design team; **b)** Every dam on a river with migratory fish should have an effective fishpass and monitoring program; **c)** Dams that have pulsing flood releases due to hydropower should systematically have a downstream re-regulating weir that levels out day to day flow oscillations; **d)** Where water quality is, or is likely to be, an issue, variable level offtakes should be mandatory.
7. Promote the development of national legislative frameworks.
 - a)** Use environmental bonds or environmental trust funds as a guarantee of compliance; **b)** Ensure the developer/owner is responsible for managing dam-related ecosystem impacts and restoring the site at the end of the project's lifetime; **c)** Ensure that the environmental components of dam tenders are at a fixed cost and are not subject to the competitive tendering process that is used for the infrastructure; **d)** Undertake regular independent audits of environmental performance of major projects where complex mitigation measures are planned; **e)** National legislation should include provision for an intact rivers policy.
8. Apply high EIA standards.
 - a)** Apply high environmental impact assessment standards with long lead times, competent staff, open process, independent review and follow-up.

Appendix 2.

Negative and Positive Aspects of Dam

Negative aspects of Dam

Dams kill rivers; dams can have devastating effects on rivers and freshwater ecosystems; fragmentation of rivers affects the migration of fish, disrupts the transport of sediments, cuts off the floodplains from life giving floods and threatens many endangered species; dams destroy [livelihoods](#) of millions of people from downstream, especially in developing countries; dams are expensive; the social and economic benefits promised for large dams and reasons have not been realized; inundation of huge tracts of inhabited land reduces the wellbeing of millions of people; creation of reservoirs flooded and destroyed many pristine biotopes, with negative impacts on biodiversity; dams transform "healthy" river ecosystems into impoverished reservoirs; downstream from dams, disruption of natural flow, sediment and energy dynamics destroys the integrity of ecosystems; although possible to mitigate against some negative effects, it is impossible to undo all the damage; large dams protect from annual floods but fail to hold back floods of longer return periods; large dams create health risks for people who live in their vicinity; hydropower is not a "clean" energy; reservoirs contribute to the greenhouse gases (i.e. decomposition of submerged vegetation releases carbon dioxide and methane); modern technologies (e.g. solar power) provide opportunities to reduce our dependence on large dams; environmental damage and degradation for human development is non-sustainable; The ecological, socioeconomic and health costs associated with their construction outweigh the benefits. The price paid is too high. Alternatives to large dams exist.

Positive aspects of Dam

Dams have improved the economic and social well-being of many millions of people; they are the most important way of making surface water available at the place and time of demand; many dams will be needed in the future to manage the world's limited water resources; dams through creation of reservoirs create new habitat for some species; the destruction of ecosystems may be resulted from the disruption of natural flow regime; large dams provide flood protection, security of millions of people who live downstream; the health risks with dams and associated projects were not appreciated in the past; we can mitigate against the causes now; dams by increasing economic status can provide the impetus for improved health care; hydropower represents a "clean" sustainable energy source; the alternatives to hydropower (e.g. nuclear and coal fired power stations) create greater environmental and social economic problems; over the last 20 years, environmental issues have come to the fore, but people (especially in the developed world) are not prepared to make the changes to their life styles that doing away with large dams would entail; We now have a greater understanding of the negative ecological, socio-economic and health consequences of large dams, and to a large extent these can be mitigated against. The benefits of dams outweigh the costs.

Source: From Reports of WCD

Appendix 2.

Differences between Bad / environmental threatening and Good / environmental friendly Dams

Bad Dams

(a) A large reservoir surface area; (b) much flooding of natural habitats and consequent loss of wildlife; (c) a large river with much aquatic biodiversity damaged; (d) a relatively shallow reservoir (sometimes with a fairly short useful life); (e) few or no downriver tributaries; (f) water quality problems due to the decay of submerged forests; (g) location in the lowland tropics or subtropics, conducive to the spread of vector-borne diseases; and (h) serious problems with floating aquatic weeds.

Environmental threatening dam

Several genetically distinct stock or species extirpated or driven to extinction; large areas of ecosystems/habitats lost or converted; 'Footprint' overlaps such areas; ecological integrity of such areas is disturbed, hampering their biological productivity; overall footprint of dam is large; several exotic species or ecosystems introduced; dam blocks routes of migratory freshwater species; seasonal flow patterns of discharge disrupted; discharge volume is greatly reduced; zero discharges frequent or prolonged; temperature, oxygen, turbidity, sediment, and acidity levels changed; methyl mercury is generated; unique habitats lost; no EIA carried out, or a poor one hastily conducted with serious impacts neither avoided nor mitigated; key decisions irrevocably made, and their input is given low priority; landscape and airscape planning and management not included in the process; water volume stored is high and wastefully used; no protected areas established.

Good Dams

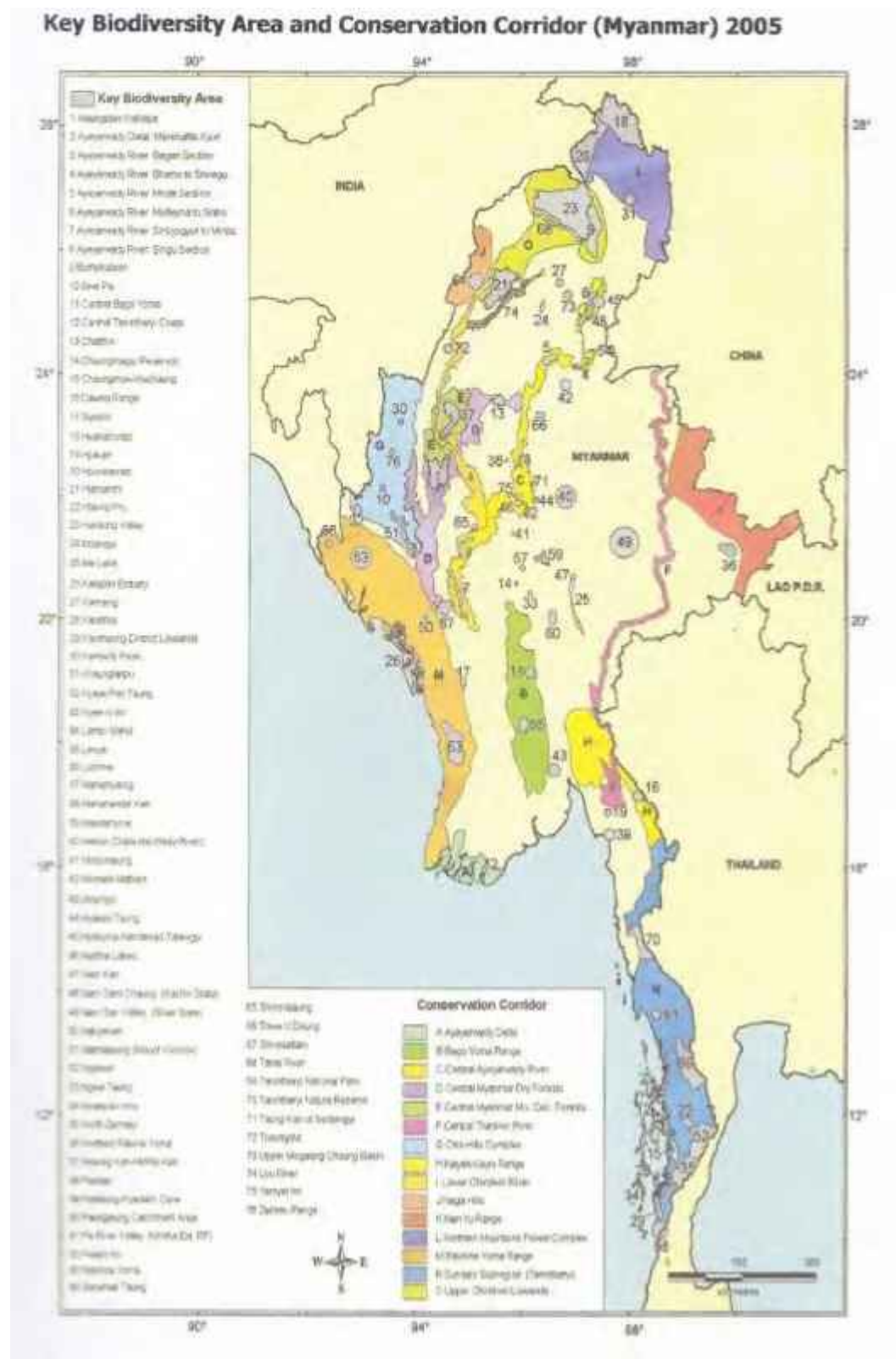
(a) A relatively small reservoir surface area (often in a narrow gorge with a high head and even a tunnel); (b) little loss of natural habitats and wildlife; (c) a relatively small (often highland) river with little aquatic biodiversity at risk; (d) a deep reservoir which silts up very slowly; (e) many downriver tributaries; (f) little or no flooding of forests; (g) no tropical diseases (often due to high elevations or temperate latitudes); and (h) no aquatic weed problems.

Environmental friendly dam

No genetically distinct stocks or species extirpated or driven to extinction; only small areas of ecosystems/habitats lost or converted; 'Footprint' of dam avoids areas rich in species, endemic species, species at risk, or diverse habitats; highly productive inland rivers, lakes and estuaries are retained in their natural state; 'footprint' of dam is small in area; no exotic species or ecosystems introduced; dam does not block routes of migratory freshwater species; seasonal flow patterns of discharge maintained; discharge volume is little diminished; water never ceases flowing; water quality is natural; no methyl mercury generated; unique habitats conserved; excellent EIA conducted and impacts avoided or mitigated; environmental staff is an important part of the dam planning and construction team from project start; landscape and air-scape planning and management are included in the process to enhance dam performance and lower water demand; water volume stored is relatively small, but efficiency is high; protected land and freshwater areas created to enhance dam performance and conserve biodiversity.

Source: From Reports of WCD

Appendix 2.



Appendix 5.

Locations of Notified Protected Areas in Myanmar

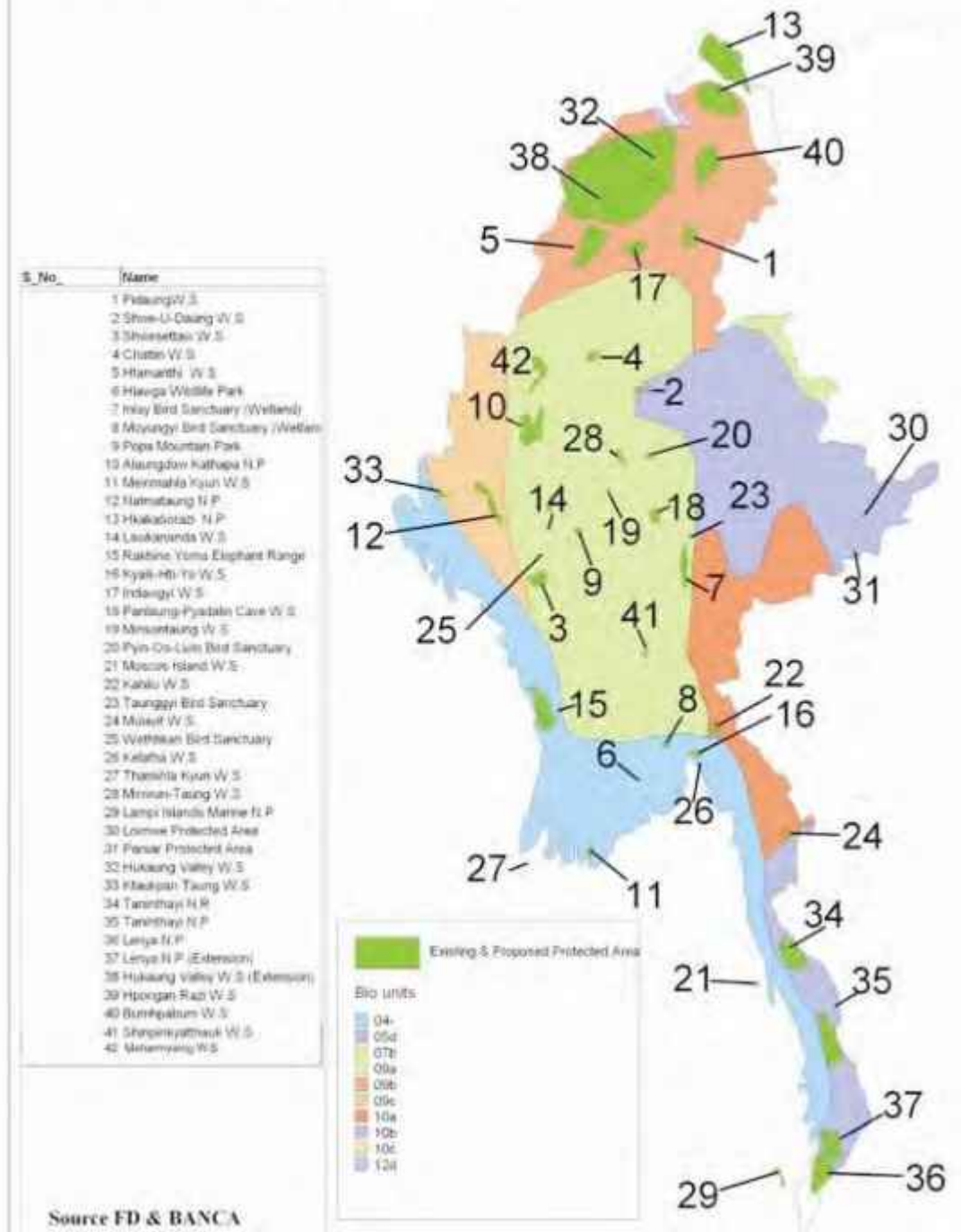
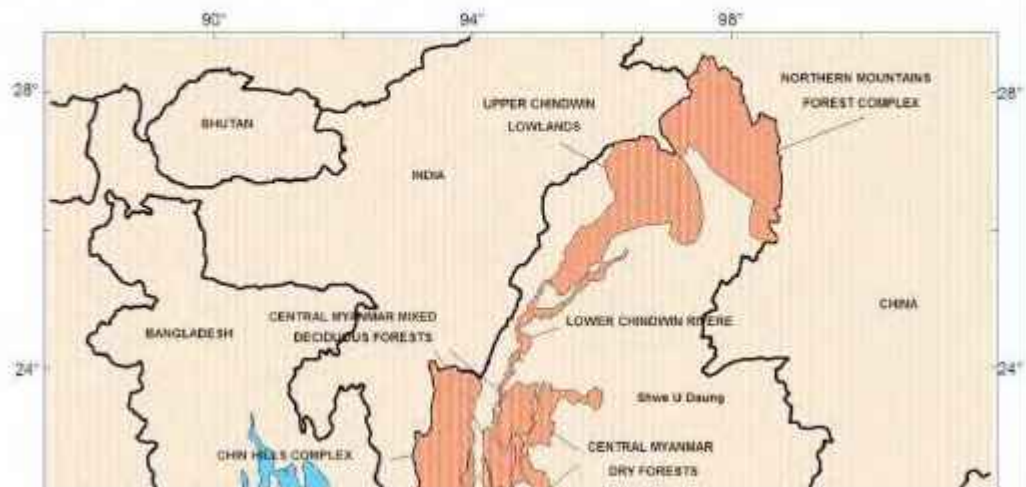
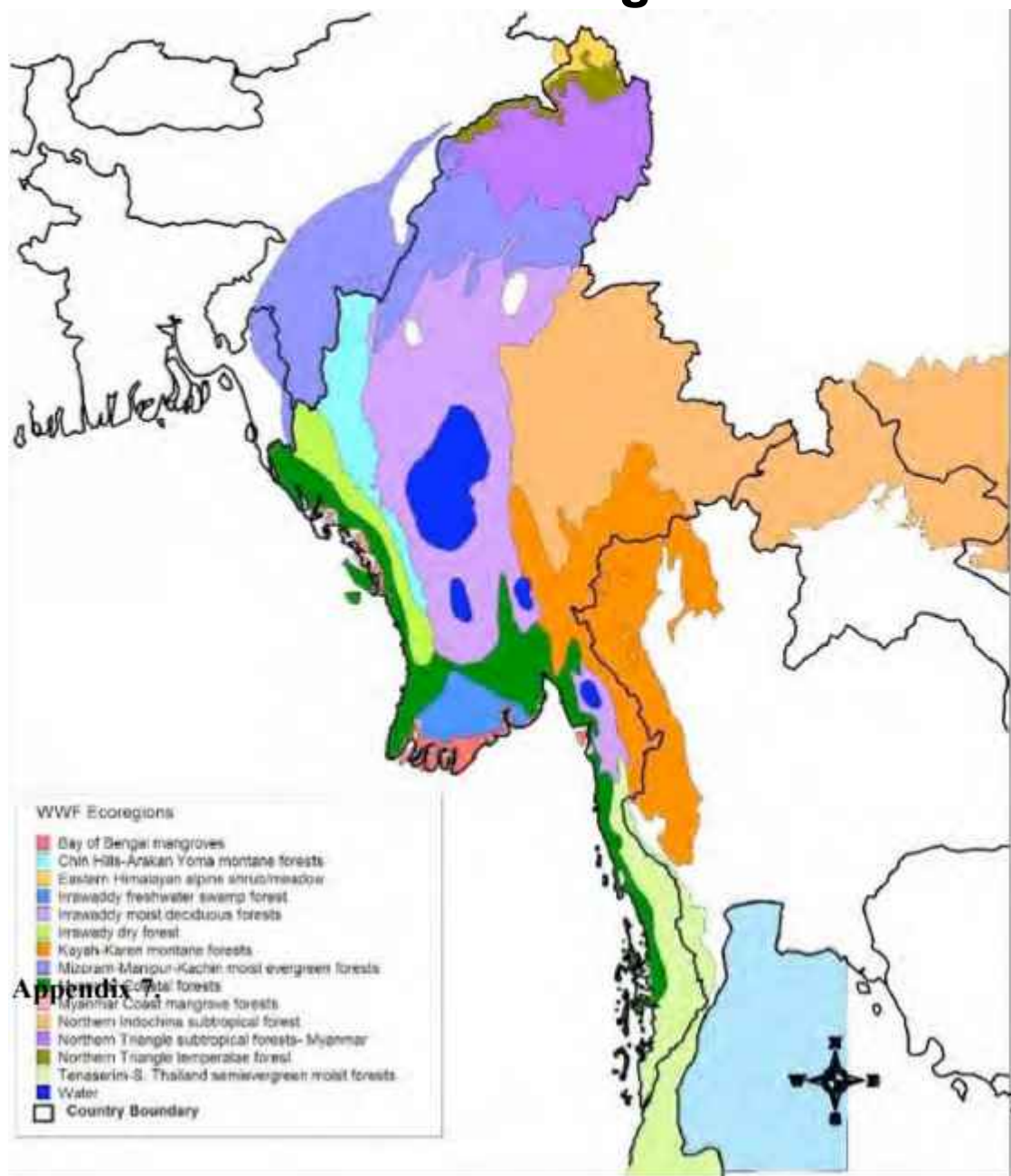


Figure 4. Priority Corridors and additional Priority Sites for conservation investment in Myanmar



WWF Ecoregions



Appendix 7:

