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CLIMATE CHANGE AND LOOMING CRISIS OVER TIBETAN PLATEAU

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ABSTRACT

Tibetan Plateau is known for its rich ecological and biological diversity. The diverse ecosystems in Tibet Plateau are home to many rare species of plants and animals. Environmental degradation of Tibet will seriously impact the livelihoods of local communities. China's rapid urbanization will continue to influence the ecology and environment in Tibet. Ecologically sensitive region like Tibetan Plateau will continue to face challenges emerging due to climate change, glacier melting, and infrastructure development. This paper summarizes the impact of coming infrastructural projects over Tibetan plateau.

Keywords: Biosphere, China, Ecosystem, Environment, Giant Panda, Infrastructure, Mineral Resources, Nature Reserve, Qinghai, Sichuan, Tibet, Tibetan Plateau, Xinjiang.

INTRODUCTION

Environmental resources have contributed for the growth of human civilization from ancient times. The development of society, culture, and religion is associated with environment. The livelihoods of ancient societies were linked with various environmental resources like river waters/lake waters, forests and mountains. The development and growth of agriculture, aquaculture, architecture, navigation, animal husbandry, transportation and arts and crafts are possible with the availability of natural resources. The role of natural resources in flourishing of civilizations in India and China is significant.

The biodiversity in ecosystems led to the development of medical sciences like Ayurveda in India and Acupuncture in China. The interaction of human societies with nature continues to leave behind significant impact on geographical ecology and global economy. Natural resources like palm leaves, contributed to the development of literature and poetry in India. Similarly, the development of paper was possible with the use of resources like bamboo in China.

Tibetan Plateau is rich in natural resources like water resources, grasslands, deserts, diverse flora and fauna and glaciers. Many lower riparian regions like East China, South Asia and South East Asian economic activities are associated with ecological prosperity of Tibetan plateau. The plateau is also home to many mountains peaks like Mount Kailash considered sacred.

ECOLOGICAL PROSPERITY OF TIBETAN PLATEAU

The plateau of Tibet (*Xizang Gauyuan*) located in the southwest China is known for its high mountain ranges on the Earth. It is the highest plateau in the world, spread across 2.3 million km with elevations that average more than 4000 meters above sea level. (*Thomson Gale*, 2003). Mountain ranges, deserts, canyons, lakes, glaciers, alpine forests and grasslands form diverse ecosystems of Tibetan plateau. Land surface features, vegetation and meteorological characteristics show variations between western and eastern parts of Tibetan plateau. The southern boundary of the plateau has rapid changes in surface elevation. (*Wu*, 2006)

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China has 2.1 million km² of land with continuous permafrost with glaciers covering around nearly 60,000 km². Most of this area with permafrost and glaciers is located in Tibetan plateau. The average annual temperature in alpine continental climate of Tibetan plateau varies between -8ºC and 0ºC, with many local variations. The river valleys in the southern part of the plateau have an average of 8ºC and summers without frost. (*Nielsen*, 2009)

The greater part of the plateau receives less than 300 millimeters of annual rainfall, whereas rivers valleys experience more precipitation. The frequency of hailstorms and thunderstorms are high in summer and strong winds in winter and spring. Tibetan plateau is a treeless wetland and steppe, turning gradually into alpine desert in the northern arid region and forests in southern and eastern edges. (*Nielsen*, 2009)

Around 65% of 152 million hectares of China's protected forests are concentrated in Tibet, Qinghai province, and Autonomous regions of Xinjiang and Inner Mongolia. (*Veeck*, 2009). Grasslands cover 41% of China's territory; Inner Mongolia and Qinghai-Tibet plateau are two large areas of grasslands. The grasses in Tibetan plateau grow shorter, tough and sparse with less moisture conditions. With an area of around 82 million hectares, grasslands are spread in 68 % of Tibet Autonomous Region (TAR) and 60% of Qinghai –Tibet Plateau. (*Gaubatz,* 2009)

The biodiversity is rich in alpine grasslands of Tibetan plateau with animal and bird species. Wild yak, Tibetan antelope, Tibetan gazelles, Himalayan blue sheep, Tibetan wild asses are mammals found in the region. The predators found in Tibet are brown bears, wolves and snow leopards. (*Gaubatz,* 2009) Grass lands of Inner Mongolia, Qinghai-Tibet plateau, Xinjiang, Gansu and Sichuan account for 70 % of sheep, 44% of horses, 39% of donkeys, 100% of horses and 25% of all cattle and goats in China. Most of the livestock industries of China are located in the grassland regions. (*Gaubatz*, 2009)

Huanglongxi natural reserve in northwestern Sichuan province, on the edge of Tibetan plateau is known for Giant Pandas habitat. Red Panda, golden snub-nose monkeys, water deer and 55 other mammal species and 155 bird species are featured at Huanglongxi reserve. The reserve is selected as World Heritage Site for natural scenery and endangered wildlife. It also has nearly three thousand natural hot pools of varied color water. (*Tuttle,* 2009)

Tibet Autonomous Region (TAR) is home to 798 varieties of wild vertebrates, of which 125 species are listed as national protected wild animals in China. The autonomous region is habitat to over 9600 varieties of wild plants and over 6400 high plants. There are 855 kinds of high plants in TAR, which are unique in the world. The rich biodiversity of Tibet provides raw materials for Tibetan medicines. Nearly 300 varieties of high plants are utilized as raw materials in Tibetan medicine. There are 93 mammal species, 497 bird species, 56 hetero-fauna and 134 fish species recorded in the Mount Kailash region of Tibetan plateau. (*Zomer & Oli*, 2011)

Nature reserves are established to preserve rich biodiversity of TAR in China. There are 47 nature reserves, including 9 reserves at the national level, 14 reserves at the municipal level and 24 reserves at the county level in TAR, China. These nature reserves are spread across an area of 413, 700 km². (*Zhang*, 2011)

Many natural reserves in China are incorporated with the United Nations Educational, Scientific and Cultural Organization (UNESCO) Man and Biosphere (MAB) Program. (Rioux, 2009) Some of the major nature reserves in and around Tibetan Plateau under UNESCO's MAB program are listed below.

- Jiuzhaighao nature reserve in Sichuan province. Located on the edge of the diverging belt between Qinghai-Tibetan plateau and Yangtze plate, the natural reserve is known for its natural scenic landscape with lakes, waterfalls and limestone terraces. (*World Heritage Convention*, UNESCO)
- Sichuan Giant Panda Sanctuaries-Wolong, Mt. Siguniang and Jiajin mountains. This world heritage site is located between Chengdu Plateau and Qinghai-Tibetan plateau with seven nature reserves and eleven parks. The sanctuaries are home to more than 30 % of highly endangered world pandas and endangered animals like red panda, the snow leopard and clouded leopard. (*World Heritage Convention*, UNESCO)
- Yading natural reserve situated in eastern extension of Tibetan plateau of Sichuan province is known for its Alpine forests. Rare animal species like leopards, black bears, Asian golden cats and golden pheasants are preserved here. (*UNESCO*)
- Mount Everest natural reserve is the highest altitude biosphere reserve in world. There are 10 plant species and 33 animal species, which are protected. It is a place for scientific research and monitoring with unique alpine ecosystems and plateau landscapes. (*UNESCO*)

The biosphere reserves listed above are impacted by Tibetan plateau in many ways. Many nature reserves are located

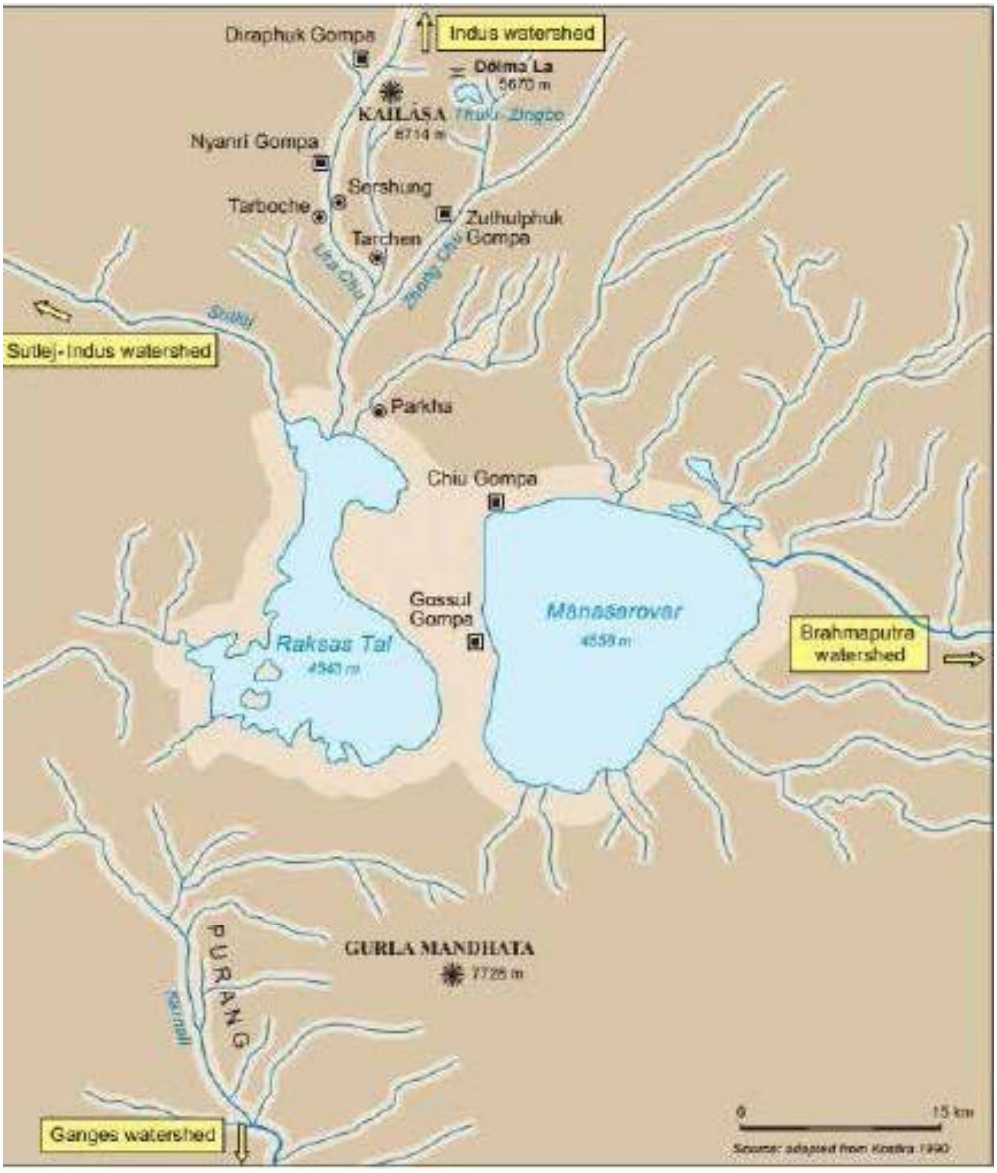
in lower regions or borders of the Tibetan plateau. The natural resources like river water flow, lakes, and forests in Tibetan plateau are essential to support the habitat of migratory birds.

The density of lakes in Tibetan plateau is fairly high with 1091 lakes exceeding an area of one km². Remoting sensing data from Landsat satellite system highlight that 11 lakes in Tibetan plateau are spread over 13, 000 km². The major lakes in Tibetan plateau are listed below

- Qinghai Lake, the largest salt lake in China;
- Nam Co, the largest holy lake in Tibet;
- Serling Co, a mysterious lake
- Zari Namco, a lake with easy fishing resources.
- Tara Yamco

(*Tandong Yao*, 2011)

Image 1: Water Sources of Asia and Sacred Landscape around Mount Kailash and Mansarovar Lake



(*Design and* ©: Hermann Kreutzmann based on Kostka 1990)

INFRASTRUCTURE DEVELOPMENT IN TIBETAN PLATEAU

Infrastructure development is essential part of any modern economy. Infrastructure plays a major role in promoting connectivity and communications between various societies and regions. The role of infrastructure development is more significant to connect western and eastern parts of China.

Western Region development of China had two important strategic goals like development of transport links between densely populated eastern coast and western interior regions and natural resource development strategy. (*Perkins*, 2004)

Western and Central China are home for concentration and distribution of poverty –stricken population in ecologically sensitive regions. The interrelation between ecological degradation and poverty is further deteriorating living conditions of marginalized populations. (*Yihong*, 2004)

Listed below are some of resource oriented industries to relocate/move to western China:

- Development of energy resources like oil, gas, coal and coal based industrial zones in middle section of the Yellow river. It includes oil industry in Gansu and Shanxi provinces;
- Non-ferrous metal industry zone in Qinling Mountains. The project also includes exploration and development of copper, gold, silver, lead, and zinc mines in Qinling Mountains;
- Development of gas, phosphate chemical and construction materials industrial zones in Sichuan Basin. The plans also include construction of natural gas industry in Sichuan province, phosphate chemical and construction industry in Longmenshan region;
- Promotion of metal and coal industrial zones in western Panzhihua- Liupanshui region. The project includes development of Vanadium Titano-magnetite in western Panzhihua region and coal industry in Yunnan province;
- Mining industry in three parallel rivers protected areas of Yunnan province. It includes promotion of metal industry in eastern Tibet and western Sichuan province and non-ferrous metal industry in Yunnan province.
- Development of metal, oil and gas industrial zones in Qinghai-Tibet plateau. These plans call for promotion of mines in Gangdise Mountains and Yajiang River, mines development at Lake Palgon and Nujiang River;
- Hydro power plants in the Western China.

(*Yong*, 2011)

The White Paper issued by the Information Office of the State Council of People's Republic of China on development and progress of Tibet/Tibet Autonomous Region in October 2013, highlights many achievements. Some of the major highlights and development projects are listed below.

- Low-income houses were built and provided to 88% of local households of farmers and headers till 2012;
- 90 % of Tibetan townships can access postal services and 99 % of Tibetan townships are connected with road network;
- 150,000 rural households in Tibet use biogas as cooking fuel and 95% of rural families use iodized salt;
- Development of various industries like energy, light industry, textile, machinery, mining, building materials, chemical industry, food processing, folk handicrafts and traditional Tibetan medicine;
- In 2012, Tibet road network had 8,896 km of high sub-grade surface and roads opened for traffic increased to 65,200km;
- Rail travel began in 2006 on Qinghai-Tibet rail line. The construction of rail network between Lhasa and Shigatse will be completed in 2014;
- Tibet had five airports and nine airlines operating in 2012. It is connected with 34 air routes linking various parts of China;
- Internet penetration in Tibetan households is 33 % with 1.47 million connections;
- Urbanization rate in Tibet is 22.75% with two cities and 140 towns.

(*Information Office of the State Council of the PRC*, 2013).

The promotion of various patterns of solar-power development by integrating intensive exploitation with distributed

utilization. The construction of large on-grid photovoltaic power stations and solar power generation projects in Qinghai and Gansu provinces and Xinjiang and Inner Mongolia autonomous regions are planned during the 12th five year plan.

Solar energy in central and eastern regions will be encouraged to construct distributed photovoltaic power generations systems linked to local buildings. Solar water heaters, solar central hot-water supply, solar heating and cooling will be popularized. The installed solar power generating capacity in China will exceed 21 million km by 2015.

China's hydropower generation are linked with ecological environment protection and resettlements of affected local people due to hydro power projects. The White Paper on China's *Energy Policy 2012*, proposes that China will strengthen ecological-protection and environment-impact assessment studies, implement measures to preserve environment at existing hydropower stations. China will increase the speed of construction of large hydropower projects on key rivers; develop medium and small sized hydropower stations. (*Information Office of the State Council*, PRC, 2012)

Tibetan Autonomous Region government in China is planning to invest 30 billion yuan for afforestation project covering Yarlung Zangbo, Nguichu, Lhasa, Nyakchu and Sengye Khabap rivers. (*Xinhua,* 2013)

The numbers of vehicles in TAR have increased to 325,000, registering an increase of 322 percent more in the last 10 years. (*Qin,* 2014) The increase of tourists to Lhasa, TAR is a regular trend with improvement of transportation facilities. In 2012, Lhasa witnessed 26.5 % increase in tourists at 6.5 million. There is also significant increase in income generated by tourism sector. (*Xinhua,* 2013)

The Qinghai-Tibet railway carried 11.73 million passengers and 57.7 million tons of cargo in 2013, with an increase of 8.8 percent and 12.percent over previous year. (*Xinhua*, 2014)

China now aims to increase highway networks in TAR to 110,000 km and rail network with 1300 km in operation by 2020. Tibet has received 83 billion yuan in transport investment in last 20 years. (*Xinhua*, 2014)

Private sector plays an important role in provide capital for investment in TAR and created 67,000 jobs in 2012. The public sector only created 24, 000 jobs in the same year. 561,000 people are employed in Tibet, which is nearly half the total number of working populations in the region. (*Xinhua*, 2013)

Most of the construction projects started in mid 1990's in TAR with huge investments, multi-categories, and large share of infrastructure and productive projects. 13 projects are involved with agriculture, animal husbandry, water and forest conservation, 17 energy projects, 6 industrial projects, 7 transportation projects and 12 cultural, educational, health related projects. (*Qin,* China Tibet Online, 2014)

ENVIRONMENTAL CHALLENGES IN TIBETAN PLATEAU

Tibetan plateau is experiencing various levels of degeneration at different altitudes and regions. The rate of ecological environment degeneration in densely populated areas is high when compared to alpine ecosystems at higher altitudes. There is also necessity for establishment of pilot demonstration site for promoting preservation technologies in Tibetan plateau. (*Zhang*

Xichang is located in southwest China and also known as "Moon City" or "Aerospace City" of China. Industrial development has led to the Xichang skyline dominated by smoke. Ecological preservation took a back seat as more investments flowed in for Western development plan of China. (*Yong,* 2011)

Research finding highlight about numerous mines set up below the mines of glaciers in Qilian Mountains. Such kind of mining activities near headwaters and protected areas create threat for availability of water resources. The mining activities were carried out at Geladandong Mountains- headwaters of the Yangtze River, in the Kunlun Mountains and Hengduan Mountains. The conditions were not different at world heritage site like old city of Lijiang in Yunnan Province and Dujiangyan irrigation system in Sichuan province. (*Yong,* 2011)

These activities are adversely impacting the flora and fauna of Tibetan plateau. Many Chinese scholars have observed that some species have been found in regions more north than their natural habitat. The Japanese white-eye bird used to live in places south of Shandong province. In recent years, it can be seen in Beijing and Yichun city. Similarly, the fork-tailed sunbird has moved north…….. The grey crane, which used to spend winter in southern china are visible in Yellow River Delta. (*Zhi*, 2011)

The habitats of giant panda continued to decrease due to deforestation in 1990's, road construction projects, hydroelectric power projects and other infrastructure projects. (*Zhi,* 2011)

China's policies for addressing Climate change released in 2008 highlights about the impact of climate change on Tibetan plateau. Climate change will shrink inland lakes and increase the glacial retreat and reduction in area of permafrost. It altered the distribution of permanent permafrost of high-altitude regions of Qinghai-Tibet plateau. (*Information Office of the State Council of the PRC,* 2008)

Table 1: China's built area, 2011-2030 Scenario

(Unit-thousand square kilometers)

Region	**Total Area** (2010)	**Total Area** (2030)	**Growth** (2010-2030)
West China	6.7	15.2	8.5
Central China	6.6	13.4	6.8
East China	14.5	19.8	5.3
Northeast China	4	5.8	1.8

(*Source*: *UNDP China*, 2013)

Table 2: Regional changes in Energy use Scenario

Region	**Energy Demand (2010)** (billion ton coe**)**	**Energy Demand (2030)** (billion ton coe)	**Share of Total Energy demand (2010)**	**Share of Total Energy demand (2030)**
Northeast China	0.325	0.702	10%	11.5%
West China	0.812	1.885	25%	30.9%
Central China	0.715	1.214	22%	19.9%
East China	1.397	2.3	43%	37.7%

(*Source: UNDP CHINA*, 2013)

Table 3: Waste Water Discharges and Treatment , 2010

Province/ Region	**No. of facilities for treatment of waste water**	**Total volume of water discharge (millions of tons)**	**Industrial waste water meeting discharge standards (millions of tons)**	**Attainment rate of industrial waste water discharge (%)**	**Total volume of sanitary sewage (millions of tons)**
Xinjiang	971	254	146	57.3	583
Ningxia	359	220	173	78.7	187
Qinghai	103	90	54	59.9	136
Gansu	672	154	128	83.3	359
Sichuan	4437	934	902	96.5	1627
Tibet	16	7	2	29.5	31
Yunnan	2044	309	284	91.8	611

(*Source:* UNDP CHINA, 2013)

Table 4: Green areas and Forest Resources in Urban Areas,2011

Region/Province	**Area of green land** (hectare)	**Coverage of forest** (%)
Xinjiang	44,097	4.0
Ningxia	18, 399	9.8
Qinghai	3,894	4.6
Gansu	16,337	10.4
Sichuan	77,406	34.3
Tibet	2,943	11.9
Yunnan	31,940	47.5

(*Source*: *UNDP CHINA*, 2013)

The provisional emissions control plans for chemical oxygen during 12th five year plan show no change in emissions in Tibet and Xinjiang autonomous regions. There is increase of 18% in Qinghai province. Majority of provinces of China have targets to reduce emissions of chemical oxygen. The emissions control plans for sulphur dioxide during the same period follow similar pattern. Tibet and Xinjiang show neither increase/nor decrease in emissions. Qinghai province will increase its sulphur dioxide emissions by 16.7% .The similar pattern is followed in emissions control plans of nitrogen oxide in Tibet, Xinjiang and Qinghai. *(UNDP China*, 2013)

CONCLUSION

Rapid infrastructure development in western regions is promoting economic growth in TAR, Qinghai province and Xinjiang. These three regions form a major part of western China. The expansion of rail networks, air travel and highways will increase carbon emissions and stress on fragile ecology. Major parts of western China have no plans to decrease their emissions of sulphur dioxide, nitrogen oxide and chemical oxygen. Qinghai province will increase its emissions by around 15%.

The western region is going to experience massive demand for energy resources and raw materials for infrastructure development. The increase of vehicles in Tibet will also increase the carbon emissions and air pollution.

The impact of infrastructure development and climate change is also visible in the relocation of some bird species at new locations. The expansion of infrastructure facilities will increase the migration of populations from other provinces. The increase in tourists in Tibet and other nature reserves will also increase the frequency of travelling in these sensitive ecosystems. The promotion of green vehicles in fragile ecosystems can decrease the impact of increased tourist inflow to Tibet.

Chinese White Paper on Tibet's development highlights about the development of various industries in TAR. It also mentions of overall prevention and treatment of heavy metal pollution. (*Information Office of the State Council of the PRC*, 2013) According to China National Human Development Report, 2013, there are just only 16 waste water treatment plans in TAR. It is the lowest among all the regions/ provinces in China. There are no plans to decrease the emissions of many gases like chemical oxygen and nitrogen oxide.

The coverage of urban forestry in western China is very less when compared with other provinces of China. Long term measures must be initiated to increase the green cover in urban areas of Tibet, Xinjiang autonomous regions and Qinghai provinces.

Tibetan plateau is critical for development of renewable sources of energy like hydropower. Most of the Chinese hydro electric projects are situated on the rivers originating from Tibetan plateau. The ecological destruction of Tibetan plateau will impact the river water flows in lower riparian regions of China and South Asia.

Western development plan of China is significant to natural resource development strategy of China. Environmental preservation and ecological regeneration are important elements for sustainable development of China.

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