

Climate Change and Its Effect on the Medicinal Plants.

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Introduction:

Overview of Tibetan Plateau: Tibet is one of the most environmentally strategic and sensitive regions in the world. Tibet is referred to as ‘The Third Pole’ and ‘The Water Tower of Asia’, which reflects the significance of its snow-capped mountains and its alpine grasslands. Since time immemorial, the plateau holds the Hindu Kush Himalayan Ice Sheet, the largest ice mass outside the two poles. Its plateau contains more than 45,000 glaciers covering an area of 105,000 km². Encompassing an area of about 2.5 million square kilometers, the Tibetan Plateau is the largest and highest region on the earth.

The major Asian rivers originating from its plateau, these rivers, *Yarlung Tsangpo* (Brahmaputra), *Macha Khabab* (Ganges) and *Sengye Khabab* (Indus River), *Drichu* (Yangtze), *Machu* (Yellow), *Zachu* (Mekong), and more provides Asia’s fresh water resource from the deserts of Pakistan and India to the rice paddies of southern Vietnam, from the great Tonlesap lake of Cambodia to the North China plain. The glacier-fed rivers originating from the Tibetan Plateau make up the largest river run-off from any single location in the world. Despite its cold environment, for thousands of years the Tibetan people occupied this plateau and created cultural landscapes based on the principles of simplicity and non-violence that are in harmony with the environment.

The Mt Kailash of Tibet is one major river contribution to Asian countries and their flora and fauna where all these four most sacred rivers of India sub-continent originate from Tibetan plateau Mt Kailash.

Indus River Tibetan call as *Singhe Khabab* is an originated from Kailash. It is one of major river in Asia which flows through Pakistan and through northwestern India, Jammu and Kashmir and China.

Brahmaputra River Tibetan named as *rTa Chog Khabab* or *Yarlung Tsangpo*. It originated from Angsi Glacier, located on the northern side of the Himalayas in Purang of Tibet as the Yarlung Tsangpo River. It flows across southern Tibet to break through the Himalayas into Arunachal Pradesh (India). It flows into the Bay of Bengal.

Ganga River Tibetan named as *Macha Khabab* – The legendary Gang originated from Mt. Kailash which rises in the western Himalayas in the Indian state of Uttarakhand. It flows south

and east through the Gangetic Plain of North India into Bangladesh, then into Bay of Bengal. It is the third largest river in Asia.

Sutlej River Tibetan called as *Langchen Khabab*. It is also originated from Mt kailash nearby Lake Rakshastal in Tibet. It is also the longest of the river that flow through crossroads region of Punjab in northern India and Pakistan

Overview of Himalayan Ecosystem: The panoramic scenic beauty and cultural diversity of the people living in the Himalaya make the highest mountains range on earth unique both ecologically and culturally. The people living in the Himalayas, belong to diverse geopolitical zones such as Tibet, India, Pakistan, Nepal and Bhutan. The Himalayan people belong to four distinct culture groups, who throughout history have methodically penetrated the isolated indigenous Himalayan population: Buddhist- Tibetans, Hindu-Indians, Islamic –Afghans and Animist South-eastern Asians. They have created their own individual and unique places. The Himalayan mountain belt is home for 14 highest peaks and it covers over fifty mountains. The Himalayan range is bordered on the northwest by the Karakoram and Hindu Kush ranges, on the north by the Tibetan Plateau and on the south by the India-Gangetic Plain. The Himalayas are distinct from other ranges of central Asia. The Himalaya is a spectacle of awesome dimension, ranges along ranges, ties of rocks, sharp sky piercing peaks and canyon deep beyond measure.

Himalaya is a sources numerous life-giving perennial rivers that have sustained / is sustaining such as rich civilization and are the basis of the life support of the almost half of humanity and Himalaya has rich diversity of flora and fauna due these life giving perennial rivers and it contain the third-largest deposit of ice and snow in the world.

Tibet and Himalaya is rich in medicinal plants: In general, the diversity of medicinal plants on earth is so vast and abundant that one cannot imagine it will ever be exhausted. We realize that Mother Nature provides enough remedies for solving various ailments which exist on this planet, but it will not tolerate self-indulgence. Tibet and Himalaya is home to many of flora and fauna adapted to the alpine temperate climate or cold climate and high elevation regions, and it is rich in biodiversity of flora and fauna coexisting in peace and harmony for centuries in their natural habitat without hindrance by modern disturbances. Classical Tibetan medical texts mention more than 3,000 medicinal ingredients used to treat various diseases. A Flora of Xizang, the Tibetan Autonomous Region of Tibet, survey and researched by a group of Tibetan physicians and scholars found more than 6,000 plants stretching from the north to Mongolia and beyond, and eastwards to Sichuan and Yunnan, north-west to Ladakh, and north-east towards Nepal and the Trans-Himalayas of India. The ancient physicians of Tibetan medicine had the great fortune to enjoy the use a virtually inexhaustible wealth of plants species for the preparation of their drugs

The Important Various Vegetations Occurring in Tibet and Trans-Himalayans belts:

Cold Steppes Vegetation: The vegetation in places of West Tibet like *Jhang-Thang*, with large-scale pasture, is related to cold steppe vegetation. The vegetation is characterized by a very short life cycle due to the cold summer. Precipitation is very low, and is mostly concentrated in summer. The plants that grow in cold steppes have soft leaves, and are often woody semi-shrubs which are spread loosely across the landscape. The vegetation is predominated by tussock grasses. These steppes are good grazing grounds for domestic animals such as yak and sheep. However, this vegetation is a very poor hunting ground for the collector of the medicinal plants.

Pastoral Semi-desert Vegetation: The vegetation is strongly dominated by pasture weeds, and contains quite a few important medicinal plants such as *Stellera* and some other species, in particularly Leguminosae of the genera *Astragalus*, *Oxytropis* and *Thermopsis*. The vegetation is scarce and patchy due to the impact of animals. It is colonized by short-life plants such as members of the Boraginaceae, whose bur-fruits and seeds are transported by animals.

Giant *Kobresia* Bogs Vegetation: This vegetation type is occupied by the dense tall, grass-like plants of *Kobresia*, adapted to the commonly waterlogged soil. It has been observed that intensive grazing of the *Kobresia* tussocks dries them out and eventually leads to their death, with decomposition of the peat surface as a consequence. The tussocks are gradually transformed into rounded hummocks, forming a very distinctive and characteristic feature of many Tibetan landscapes and ecosystems. While the dense *Kobresia* tussocks leave very little space for other plants, some medicinal plants grow in between, such as *Pedicularis* spp.

Alpine Cushion Vegetation: This type of vegetation is opened up by grazing or peat-cutting. It is an alpine semi-desert growth with very sparse vegetation development. The distinct characteristic of this vegetation type is the presence of plants such as *Arenariaspp.* or *Androsacespp.*, which grow in dense cushion form.

Conifer Forests Vegetation: The lower Himalayan belt is sparsely occupied by conifer forests. Juniper trees grow in areas with southern exposure, but they are replaced by *Pinus* spp. on lower slopes, which are less exposed to drought. Species of cypress prevail near the lower tree-line. The vegetation becomes more woody, and dwarf *Juniper* covers these areas. This area contains a wealth of medicinal plants such as *Aconitum sp*, *saussurea lapp* and *Inula racemosa*.

Birch Forests Vegetation: This kind of vegetation occurs on slopes with a northern exposure, with a high snow cover and humidity. It is dominated by the famous Himalayan birch, *Betulautilis*. It is an impressive tree with a short trunk and spreading crown. Birch trees are very useful for the local inhabitants, who use its leaves, bark and wood in their daily livelihoods. However, excessive consumption has brought the birch forests in many parts of Himalayan to the verge of extinction. Some high altitudes medicinal plants prefer the conditions provided by these forests, such as *Podophyllumhexandrum*.

Subalpine Herb Meadows Vegetation: The vegetation of these areas was formerly occupied by moist birch forests, and includes tall herb communities. The tall herb community is a group of

plants showing a relatively similar growth form and life cycle (sprouting in late Spring, and growing four to five months), under these special environmental conditions. The plants belong to the families of *Polygonaceae*, *Ranunculaceae*, *Labiatae* and *Umbelliferae*. These plant communities grow below the tree-line, in the undergrowth of open forests and shrubberies. It grows on slopes exposed to the north and on the banks of rivers and small streams in particular. This vegetation is the most developed and particularly conspicuous on sites where tree growth is prevented by high, long-lasting snow cover, or slopes frequently struck by avalanches or mud slides. Such conditions are unfavorable for trees and shrubs. Herbs avoid the pressure of the heavy snow cover by overwintering at or below the soil surface.

They are mostly perennials that sprout rapidly in late Spring, making use of nutrients from their underground storage organs including herb such as *Aconitum heterophyllum*, *Delphinium vestitum*, *Pediculari spectinata* and *Geranium wallichianum*.

Alpine Scree Herb vegetation: Scree slopes are Typical natural habitat of mountain. Their common characteristic is that plants are constantly in danger of being damaged and covered by debris falling from cliffs above, plant such as *Rheum nobile*.

Boulder Slope Herb vegetation: Boulder slopes are home to a great varieties of micro habitats ranging from rocks fissures to extremely shaded, moist, shelter, cave-like places where the snow is persevered until summer and plant such as *Bergenia stracheyi*

Alpine Humid Pasture Vegetations: This vegetation type consists of meadows of rich tall as well as small herbs, with medicinal plants such as *Iris* spp. and *Phomis*. The vegetation is affected by increased grazing on these meadows, which are then transformed into grassland with patches of the most unpalatable and resistant herbs like *Iris* spp. In this short-grass vegetation, low-growing and creeping plants such as *Lagotis* spp., some *Gentiana* spp. and *Cyanathus* spp. occur in large amounts. Some of the more tender *Pedicularis* species also find a suitable habitat in these areas. This vegetation is rather similar to alpine turf above the tree-line, which gradually dissolves into more patchy vegetation with increasing altitudes.

Dwarf Scrub Vegetation: This vegetation occurs in the subalpine zone of the Himalayas and of southern Tibet. Dwarf scrub replaces relatively dry birch forest on the upper slopes, having a relatively high snow cover in winter. The vegetation is dominated by small woody shrubs and many of these plants belong to the Ericaceae family, which are called dwarf shrubs and have special adaptations to drought. They are found on slopes with a relatively high but short snow cover.

Montane *Caragana-Artemisia* Scrub Steppes Vegetation: This type of vegetation commonly occurs in dry parts of the Inner Himalayas and particularly the Tibetan Himalayas, and in India's Zaskar and Lahual and Spiti regions. It is very similar to cold desert vegetation. The vegetation in these dry areas is very much degraded by the impact of overgrazing. It is mostly dominated by scrub such as *Caragana* species and *Artemisia*. These *Caragana* species are thorny leguminous

shrubs. Other thorny shrubs such as *Rosa* and *Berberis* species also grow in these drier areas. *Caragana* is collected by local inhabitants as fuel and for fencing.

Cold Desert Vegetation: The western and northern regions of Tibet are cold desert regions. In India, the trans-Himalayan zones fall under this category, i.e. Ladakh in Jammu & Kashmir, and Lahual and Spiti in Himachal Pradesh, as well as very small pockets in Garhwal in Uttar-Kashi with similar climatic conditions. The vegetation is dominated by pasture of small grasses and annual and perennial herbs followed by a few dwarf bushes or shrubs. The vegetation growth begins with the onset of summer, when the melting snow provides abundant moisture to the plants. These barren mountains then become a spectacular display of a variety of flowers and plant species during July and August, on slopes, in patches of alpine meadows, moraines and pastureland.

The Depletion of Tibet and Himalaya Vegetation Due to Causes by Climate Changes and Global Warming:

A natural wealth of flora in the alpine and high altitudes regions particularly in Outer and Inner Himalayans belt, home for many plants species are depleting due to the alarming rate of unseasonable weather events and global warming on the planet. The unseasonable weather events and global warming not only affect the alpine temperate vegetation but also Tropical and sub-Tropical vegetations. As a result some regions in the high-altitudes areas have become a barren desert. The lower altitudes area or hills and plains have also become barren with sparse vegetation. Another added factor is that of grazing cattle; wild and domestic herbivores affect vegetation in high altitudes areas. Therefore many areas of high altitude tends to develop into a desert due to unseasonable weather events, global warming, the human impact and overexploitation, in particularly overgrazing, avalanches and decreased snow fall in winter.

Climate Change Impacts: Climate change impacts in Tibet are vast and it affects almost everything from the disappearance of certain native plant species to the melting of glaciers. The Scientific research report states that the whole of the Tibetan Plateau is heating several times faster than the global average. With this heating, it creates a ripple impact(s) throughout the Asian continent, starting from glacial meltdown, permafrost degradation, desertification, drying up of wetlands and the subsequent climate feedbacks. It is estimated that the glaciers on the Tibetan Plateau are currently melting at a rate of 7 percent per year and a separate study revealed that 20 percent of Tibetan glaciers have retreated in the past 40 years and if the current trend continues, more than 60 percent of the existing glaciers could be gone in the next 40 years.

Loss of Carbon Sinks from Degraded Grassland (Herbal Pasture): Wetland as carbon sequesters throughout the world plays a pivotal role in recharging the aquifers in the arid and semi-arid regions of the world. Wetlands in Tibet play a major role in regulating the flow of rivers and also are the major carbon stores. They act like a sponge, absorbing water during the summer when the water is in excess and releasing it in the winter when the runoff is short.

The grasslands on the Tibetan Plateau represent one of the last remaining agri-pastoral regions in the world. The pasture lands are the highest and coldest on the Earth, made habitable through the co-existence of the Tibetan people and their yaks. Through their efforts the nomads and herders have maintained the sustainable use of these areas for many centuries. The alpine cold steppe and alpine cold meadows or medicinal pasture being the most dominant ecosystem on the Tibetan Plateau occupy over 60 percent of the total area storing a large amount of organic carbon (Jin et al. (2000.)) The global warming climate influences the emission of soil carbon from the pasture or grassland and meadows.

Degradation of Himalayan plants is Caused by the Following Factors: Unfortunately, much of the flora and fauna existing in the alpine temperate and high altitude regions as well as lower tropical and sub-tropical vegetations is decreasing due to deforestation, over-exploitation, unseasonable weather events, pollution, over grazing, fire, floods, drought, disease and destruction of habitat because of industrialization, urbanization, roads and water reservoirs constructions. The consequence is that some important and valuable medicinal and aromatic plants are becoming rare and scarce in their natural habitat.

They are now verging under serious threat. Hence conservation and protection of above mentioned bio-wealth is a topmost priority of the nation as well as responsible for Industries, giant pharmaceutical company, Medical Institutions, Health care organizations, which can be achieved by adopting complementary approach of in-situ and ex-situ strategies throughout the medical system in their communities.

Impacts of climate Change on People's livelihood in high regions: The subsistence of people living in high altitude regions is based on some cash crops such as wheat, barley, mustard, oat and pea and potato, beans and radish, fruits such as apple, apricot and walnut. They also grow medicinal plants such as *Sassurea lappa* and *Inula racemosa*. Despite the harsh climates they very much depend on these resources. In recent years, these local communities are facing lots of challenges in their livestock and livelihoods due to climate changes and global warming threatening their survival. During the last nearly two decades my medicinal field trips to alpine high altitudes areas, I had had numerous contacts and interaction with these local inhabitants about the alpine vegetations and ecosystem and their lives. Especially I was fond of asking about climate changes and how its impact to their livelihood. I do remember local old women age of 70s at Nubra valley "I grow potato as a cash crop which has failed completely these last few years due to rain failure. But this year I lost my house and agricultural land in the flood. Only God can help us now from dying."

Tourism and Trekking Parties: One important factor which leads to depletion and less number plant species in alpine regions is tourism and trekking parties. As I have mentioned in my book on Cultivation and Conservation of Endangered Medicinal Plants more and more people are engaging and taking holidays in the high alpine mountain of Northern India and the Himalaya borders without concrete aims and objects apart from their pleasure and happiness.

Unknowingly, they are a threat upon vast fields of tradition medicinal plants, which are not just pretty on the green slopes, but can heal people and save lives.

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