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Review

Traditional ecological knowledge and natural resource management: Some examples from Bangladesh

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Abstract: Traditional Ecological Knowledge (TEK) refers to the knowledge, innovations, and practices of indigenous and local communities around the world. As it includes proven technologies for particular situations, its adoption cuts research costs and time. This paper attempts to find out the scoping of some TEKs on different practices ranging from plain land agriculture, hill farming, agro-biodiversity management, open water fish conservation, disaster management, and other aspects in different situations in Bangladesh. It is an outcome of the authors' field experiences in the study of local flora, plant uses, and natural resource management practices in the community and a review of related literature. Access to modern facilities, urbanization, and land use changes are now causing many threats to TEK. Documentation and codification of this knowledge and its uses for sustainable development are needed for the betterment of local farmers as well as the preservation of cultural heritage. The knowledge is always changing to cope with socio-cultural needs. So, a fusion of TEK and modern scientific knowledge can help solve the problems encountered in the sustainable management of natural resources. It also needs to be incorporated into school curricula and mainstreamed in the local-level natural resource management planning process. The best practices can also be adopted in natural resource management.

Keywords: biodiversity; sustainable development; indigenous knowledge; local knowledge; traditional knowledge

1. Introduction

Traditional usually refers to "cultural continuity transmitted in social attitudes, beliefs, principles, and conventions of behavior and practice derived from historical experience" [1]. Ecological means related to ecology, meaning the relationship between living beings and their environment. Knowledge is the facts, information, and skills acquired through experience or education; it is the theoretical or practical understanding of a subject. According to Levin [2], TEK is a cumulative effect of the knowledge, practice, and belief of the people, which evolves through adaptive processes and is transmitted through generations. Thus, it is a holistic system of knowledge, practice, and belief complex in a society [2,3]. It is a continuation of the resource-use system of a particular land. It is also designated as a subset of indigenous knowledge, generally unique to a given culture or society. Local and indigenous knowledge is often used synonymously for the skills and wisdom of local communities developed through interactions with their natural surroundings [2].

A review by Mathias [4] gives the conservational aspects, merits, methodologies, and usefulness of TEK in sustainable resource management. Though the importance of the TEK is recognized for natural resource management, this knowledge system is now in danger of erosion due to rapidly changing environments and reckless shifting

economic, political, and cultural phenomena from a global standpoint [5]. For the sake of biodiversity conservation, food security, and the protection of the world's natural resources, TEKs need to be preserved, revived, and integrated into mainstream planning [6].

Article 8 (j) of the Convention on Biological Diversity (CBD) calls for the conservation of traditional knowledge. Promoting TEK can also help achieve the Sustainable Development Goals (SDGs). TK is sometimes linked with the culture and diversity of a society [7,8] and is environmentally and socially appropriate and sustainable [9]. Subramanian and Pisupati [10] highlight the significance, opportunities, and challenges of sector- or system-wise adoption of traditional knowledge, their adaptive capacities (environment management and climate adaptation), governance processes, ethics and equity, and the process of mainstreaming TEK in the sectoral planning process. Recently, Rai and Misra [11] presented a nice compendium on the concept, practices, and issues of TEK in the realm of indigenous natural resource management techniques in Asia.

Most TEK reports from Bangladesh include ethno-botanical studies and are mostly on food and medicinal plants. There are a wide variety of underutilized food plants in Bangladesh [12–14]. The majority of reports on the traditional use of plants are from the Chittagong Hill Tracts (CHTs) region. The recording of TEKs from CHTs dates back to Lewin [15]. A good number of reports also exist on the scope of integration of TEK in different farming subsystems like agriculture, fisheries, non-wood forest products, and sand disaster management in Bangladesh under different agro-ecological and socioeconomic environments [16–29]. TEK is to some extent used for local decision-making processes in a variety of fields, including plain land agriculture, hill farming systems, fisheries and freshwater ecosystems, and disaster and climate forecasting in Bangladesh. This study focuses only on the importance of TEK in managing natural resources.

2. Methodology

The article is mainly based on author's experiences from field observations documented on different traditional practices and innovations of different farmers' communities from Bangladesh recorded over four decades. The author also used the information from secondary sources through literature review.

3. Documented TEKs

3.1. Plain land agriculture

3.1.1. Homestead an integrated farming system

Homesteads are unique ecosystems of rural Bangladesh. Human settlements throughout most of Bangladesh are mostly in villages which comprise both dwelling houses and other production farming components like vegetables production, fruit production, tree production, poultry, livestock, even small shops, processed foods and even cottage based manufacturing units. The plant based production system presents a prototype of a typical tropical multi-layered forest. Interacting with nature people from rural Bangladesh over time have acquired knowledge on land use, site specific

species selection, their cultivation, utilization, management, conservation and value added product development.

3.1.2. Integrated pest management

Farmers encourage and facilitate birds sitting for preying insects in paddy fields. They put bamboo sticks, brush woods of trees in rice fields for landing and sitting of insect preying birds; spraying neem leaves solution to control insects on vegetables, dusting tobacco powders to control insects, dusting ash to cucurbit vegetables to check aphid attacks, intercropping of garlic and potato to minimize pest infestation, etc. [27].

3.2. Hill farming

About thirteen ethnic communities live in Chittagong Hill Tracts (CHT [30] and have their own traditional knowledge. The member of hill communities in the CHT developed different location and community specific farming practices. Shifting cultivation locally known as jhum is the main cultivation practice in the CHTs. Following are some TEKs relating to hill farming practices in the CHTs.

3.2.1. Land use zoning

Generally, hill people consider land type, topography, hill slope gradation, aspects, soil texture etc. for making use of land for agriculture and production purposes. These local knowledge based landuse plans are ecologically and socially very sound. They follow some sorts of zoning for land use planning. The broadly classify land types into three land use categories as given in **Table 1**. In addition to these they also use the streams and water courses (jhuris and charas) for multiple purposes.

Table 1. Land use classification practices by four hill communities in the CHT.

Zoning categories	Marma	Murang	Tanchangya	Bwam	Characteristics
Villages or Para	*Rowa*	*Kowa*	*Aram*	*Kuwa*	Villages comprise cluster of houses
Farming sites or *Jhum*	*Yah*	*Yowa*	*JhumJa*	*Laow*	Main cultivation on the hill slopes
Fallow *jhums* or *Raiyna*	*Ran Min song, Wang MiWah*	*RainyaJa, Ja Bhui, Tarong*	*Reserve or Kowa reserve*	*Reserve*	Kept undisturbed after *jhum* and again used for *jhum* after few years

3.2.2. Indicators for *Jhum* land selection

The shifting cultivation, locally termed as *jhum* is the major farming practice in CHTs. It is a slash and burn system mostly practiced in hill slopes. It provides major crops for the sustenance livelihood of the hill people. Generally, people follow following in selecting a jhum site:

- gentle slopes (generally the middle portion) are more preferred to the steep slopes;
- bamboo vegetated lands;
- lands covered with *kurjuklota* (*Mucuna* spp.);
- the area covered with *ramkola* (wild banana) is supposed to be suitable for chili cultivation; farmers think that the banana ashes enhance chili production in the *jhum*;
- loose textured soils with no gravel or least gravels;

- soils with earthworm burrows and colonies.

Farmers prefer a little admixture of gravel in soil in selecting land for fruit orchard establishment. Hills consisting of sandy loamy soils are considered as good site for village establishment. Sandy loam texture provides perennial seepage water to the streams. Thus, most of the hill villages are established along the streams.

3.2.3. Periodical sowing of seeds in *jhums*

Considering the harvest time, seed size and other managent needs the farmers follow some periodic sequence in seed sowing in *jhum* field. Generally they sow seeds in three stages in the *jhums.* Generally, in *jhums* seeds are dibbled in small holes. But crops with small seeds (*Ocimum*, *Capsicum*, *Coriander*, etc.) are broadcasted all over the field as soon as fields are cleared and ready for sowing. Seeds of rice, cotton, maize and other vegetable crops by dibbled after a week of first broadcasting. When the rice seedlings attain about four inches in height, farmers broadcast *til* (*Sesamum indicum*) seeds. It is reported that if the *til* seeds are sown with rice it hinders the growth of the rice tillers. This is a system to avoid allelopathy of sesamum-rice interaction at germinating stage.

3.2.4. Knowledge on local climate condition for climate resilient crop selection

Climate is an important parameter for selecting crops for a particular area. The *Murang* community of Empu Para, Bandarban district had selected crops for the area based on local climatic conditions. At high altitudes the night temperature is cool. This climatic condition is locally called as *thanda* (coldness). Climate at lower elevation climate is a bit hotter and locally called *gorom* (warmness). The farmers of Empu Para at a higher altitude in Chimbuk hill range (about 875 m) grow citrus fruits like orange (*Citrus reticulata*), malta (*Citrus sinensis*), jambura (*Citrus grandis*), and satkora (*Citrus macroptera*) etc. in addition to *jhum* farming.

Empu Para is situated at higher elevation than Bandarban and Ruma. The night temperature is comparatively cooler in Empu Para and this condition is locally called as *thanda* and considered as suitable sites for citrus cultivation and not suitable for ginger cultivation. Foggy weather during flowering time is considered to be suitable for good citrus fruit setting. On the other hand, Sharon Para is comparatively hotter (*gorom*) than Empupara, and, considered suitable for ginger cultivation. Climate is considered comparatively warmer (*gorom*) in Ruma and Bandarban than Empu Para, and farmers grow here pineapples, mango, banana, *lichi, boroi* and *papaya*. This knowledge can play important roles in selecting climate resilient crop selection [23].

3.2.5. Altitude and wind velocity in selecting crops

Altitude and wind velocity are considered important in selecting crops. The farmers at high altitudes do not cultivate *til* (*Sesamum indicum*) in *jhum*, because when the *til* fruits ripen, the pods split up and disperse seeds for high wind velocity. This is an important criterion for crop selection where altitude is a factor [23].

3.2.6. Broad zoning of hill Slopes for different crop cultivation

Slope gradation is an important factor in hill cultivation. Generally, the foot hills or base of the hills are rich in moisture content and nutrients. Local people have knowledge about slope situations and species suitability along different slope gradients. Crops of different habits such as annual crops (like aroids, gingers) are

planted towards the lower slopes and foothills. Mid-slopes are preferred for fruit trees. Toward the hilltop people generally plant timber trees.

3.2.7. Insect repellent barriers by cultivation of ornamental plants along the periphery of *jhum* fields

Hill farmers plant some showy ornamental flowering plants particularly of Asterace family along the periphery of *jhum* field for beautification. Mostly merry gold, coxcomb and cosmos flowers are planted. It is a belief of farmers that pungent smell of ginger, onion, mint and pepper and bright flower colour work as an insect repellant. It could be a good biological pest control approach. This practice will help to reduce insect attack at field with any use of insecticides and pesticides.

3.2.8. Indigenous seed collection process

Local seed collection is simple and hygienic. Farmers prefer to collect seeds from disease free mother source. Generally, people select healthy mother plants and collect mature and bigger sized fruits from them. In case of upland paddy farmers harvest the desired crops in a sunny day thresh them immediately after harvests. For fleshy big fruits like gourds farmers put some rice straw beneath the fruit in the field, so the they do not touch the soil. Farmers dry extracted processed seeds in sun for 7–10 days and store them in bamboo potsor hallow gourd pots. To protect seeds from insect attack and maintain optimum levels, seed jars are stored near fire place or hung under roof over stoves. This is how the hill people maintain the local germplasms of different crops [26].

3.2.9. Traditional seed storage techniques

Almost all hill farmers from different tribes follow similar seed storage systems in the CHTs. Traditional seed storage techniques practiced in the CHTs are given in **Table 2**. This is an economic and sustainable system of seed management for the hill areas.

Table 2. Indigenous crops storage process practiced by hill people of CHT.

Seeds types	Indigenous storage process
Paddy	Stored in bamboo made baskets locally called *turong*. Seeds are covered with dried leaves of banana (*Musa* sp.), teak (*Tectona grandis*), moos (*Pterospermumacerifolium*) or palm (*Caryota* sp.) to maintain moisture.
Cucurbits seeds	Washed thoroughly with water and sun dried for seven to ten days and stored in locally made bamboo small baskets (*Turong*).
Other Vegetable seeds	Stored in earthen pots or in *toyea* (*hard shell of gourd*) and keep them in a warm dry place usually attached with the kitchen wall.
Maize seeds	5–10 bunches are knotted together and kept hanging from kitchen roof to keep seeds viable and free from insect and fungal attack.
Ladies finger, Borboti (bean)	Tide up together and kept hanging from roof of kitchen roof to avoid insect and fungal attack.
Tulsi (*Ocimum* sp.)	The whole plant is dried and kept beneath the house roof.
Root crops	Tubers or roots are stored in dry places covering with soils near their house. Aroids stored in field or in bamboo basket (*Turong*) covered with grass and placed in shade near their house.

3.2.10. Conservation of germplasm through seed distribution

A community based traditional seed sharing system still exists among the *Marma* peasants in the CHT, more than ten local upland varieties of rice are cultivated in the hills of CHT. Each family generally maintains germplams for 3–4 varieties. Farmers exchange among themselves the different varieties as they desire to plant. This

community-based seed sharing system had been an effective method of maintaining agro-biodiversity over time and localities. This also helps in maintaining community and reduced the storage risk.

3.2.11. Indigenous nursery method for citrus

Orange and pumelo are two important cash crop for income generation to the *Murang* community in Empu Para. The hill farmers have developed indigenous method nursery rising for citrus seedlings. They raise citrus seedlings in bamboo baskets. An abandoned bamboo basket is filled with soil, or a bamboo platform layered with soil is made at about one meter above the ground. Seeds are sown in the baskets or into soil layers on platforms. The seeds germinate in the baskets and soil beds in bamboo platform. After one year the seedlings are pricked out and transplanted in the seedbeds in the field. The perception behind this practice is to keep the seedbed away from the disturbances of poultry birds, pigs and to easy nursing the seedlings. When the seedlings attain about one meter height, bare-rooted seedlings are planted in the field during the monsoon. In this practices, local resources based biodegradable containers are used and thus it environmental friendly and economic [26].

3.2.12. Ginger field management through mulching

Ginger is a cash crop in the CHT-hill farming system. It is a practice of the hill people in the CHT to mulch the ginger field after sowing. Hill farmers use to mulch ginger fields with brush wood harvested from fallows. But they prefer to mulch with old thatching grass (*Imperata cylindrica*) abandoned from thatched roofs. The abandoned thatched grass decomposes at a slower rate than brush wood. This practice suppresses grass and other weeds, and increases the soil temperature that helps ginger in emerging shoots. Mulching material in the long run decomposes and adds humus to the soil.

3.2.13. Indigenous ginger storage method by the *Bwam* community

Ginger is an annual crop growing important spice with good market potential all over the country. It cannot be stored in open condition for longer period after harvesting. Storing of ginger for longer period can bring better price to the farmers. But there are no modern storage facilities for ginger storing in the hill areas of Bandarban. So, innovated *Bwam* farmers of Sharon para, Bandarban have developed Indigenous ginger storing method, which help them to enhance their income. In this method farmers store ginger in large pits dug in the soil. To store ginger the farmers dig large rectangular shaped pits near their houses. They make a sand layer at the pit floor and put fresh gingers on the sand layer. Then spread a layer of hay, rice straw or other dry grasses over the ginger and cover with soil. A shed of thatched roof is made over the pit and a drain is made around the pit to protect it from the rainwater. This system does not any additional space and capital investment. Thus, it is economic method to maintain soil moisture and to reduce the soil erosion [26].

3.2.14. Silvicultural management of trees in the *jhum* field by the *Murang* community

During preparation of jhum field farmers generally slash and burn the existing woody l vegetation from the site. But the Murung community members in Empu Para keep some important trees like *Albizia* spp., *Derris robusta* and other leguminous trees

and *Ficus* spp during field preparation. When they fell trees they cut them at about one-meter height above the ground so that browsing animals cannot reach coppiced shoot at this height. The newly produced shoots become susceptible to wind break. Many *Murangjhumias* of Empupara lop the branches of the retained trees for easy light penetration in the ground. This is some sort of aidded natural regeneration process towards restoration of ecosystems.

3.2.15. Indigenous knowledge for mushroom identification

Mushroom is delicious food to hill people and locally called *ul* or *ulli* (Chakma) with potentials in local markets. Wild mushroom naturally grows in the forests and the hill people have knowledge of differentiating edible from the poisonous ones. The clump forming mushrooms growing on dead logs, bamboo culms and soil are considered as edible. On the contrary non-clump forming mushrooms are considered poisonous. Sometimes the hill people do hydrated quicklime test to determine edibility of mushrooms. Hydrated quicklime is applied on the fruit body of the mushroom. If lime applied area becomes black then it is considered as poisonous. The mushroom covered with the ants is considered as edible by the *Tanchangya* tribe. The mushroom growing on logs of *dharmara* (*Sterospermum personatum*) and *gamar* (*Gmelina arborea*) are considered as edible. In *Chakma* and *Tanchangya* language the the mushroom is called *ul.* A folk classification of edible mushroom by the *Tanchangya* community [23] is given below.

- *Thompuul*: Clump forming mushroom growing on the soil.
- *Bas ul:* Large mushroom on soil, sweet in taste.
- *Kala ul:* Mushroom that grow on the debris of Banana.
- *Thiniaul:* Red mushroom that grows on decade wood along the streams.

3.2.16. Gamar coppice management

Gamar (*Gmelina arborea*) is a fast-growing timber tree species planted in private forestland. Indigenous people have developed a coppice management system for *gamar.* Felling cycle has been fixed for 10–12 years cycle. The timber is harvested during dry months and cut at about 15 cm above the ground level. The stumps are protected from browsing. Profuse coppice shoots develop from stumps within 15–30 days. Selected coppice shoots are retained and managed for next rotation.

3.3. Ecosystem services and management

3.3.1. Management of catchments areas

Traditionally the local people manage and maintain catchment areas. While preparing jhum fields they maintain vegetation cover at the upper catchments without any disturbance of the vegetation what ensures continuous flow of stream water. Even when they prepare *jhum* land they keep a strip of vegetated land along the foothills to protect soils from erosion and adjacent land from *jhum* fire.

3.3.2. Stream banks protection

To protect canal banks from erosion and conserve soil water hill people plant a bamboo locally called *baijja bans* (*Bambusa vulgaris*) along the canal banks.

3.3.3. Seasonal cross dam and small scale irrigation

To irrigate downstream agricultural fields the hill people in the CHTs make earthen cross dam across the streams, which is locally called *Goda*. In addition to irrigation local people use this water for domestic purpose.

3.3.4. Water harvesting ditches

Seepage water harvest for domestic purposes is a traditional system in hill of CHTs. The seepage water flows downward through narrow channels (locally called *jhiris*). People dug small rectangular shaped ditches at the base of the hills for reserving seepage water and the excess water is let out through a small hole. For steady supply of seepage water in the streams the vegetation at hill top is kept intact and nobody is allowed to harvest any timbers and fuel wood form the area.

3.4. Yam harvest by forest dwellers in mid land Sal forests

3.4.1. Regulated wild yam harvest by the *Mandi* community

The *Mandis*, a forest dwelling community in mid-land *sal* forest of the country depend to some extent wild food plants during the months of November to February. During this period, they generally collect wild yams from forests. They dig out yams removing soils around the tubers by shovel or spade. While harvesting people cut the yam tuber keeping few centimeters of yam below the collar zone and the basal part of the stem. Then, the dugout whole is again filled with soils where the new yam tuber develops. Soil works during digging process make soils loose that make space for development of new yam tubers. It is learnt from the people that if the matured yam tuber is not collected then it is rotten under the soil. This harvesting practice is a sustainable mode of production and consumption.

3.4.2. Yam processing by the *Santals*

Sliced yams are kept in running water in the stream overnight to wash away of bitterness.

3.5. Tree based agroforestry in mixed evergreen forests

3.5.1. Betel leaf farming by *Khasi* communities

Betel-leaf (*Piper betel*) cultivation using forest trees as support is a cash-oriented agroforestry system by the *Khasi* communities in north-east forest areas of the country. Existence of a good density of standing tress is an important criterion in selecting a farm site. Generally, the betel-leaf growers do not extract any standing tree from the farm stand, but further allow seedling to grow. From their experience they maintain a tree density per unit area. Thus, this production system plays an important role in biodiversity conservation, particularly of tree diversity. A study by Haider et al. [31] recorded 86 plant species in *Khasia* betel-leaf farms as support tree. Stocking density of trees in farmland is 1452 trees per hectare excluding seedlings and saplings, with a wide variety of diameter classes.

3.5.2. Bio-safety measures: quarantine against *Utram* disease (leaf rotting by *Phytophora* sp.) in Khasi betel-leaf farm

No outsider is allowed in to the farm. Keep water at access gate to wash limbs while enters in to the farm. After getting back clothing are washed with a shower.

3.6. Floating agriculture

Floating agriculture (*Dhap*/*baira*)

Farmers' innovative practice growing vegetables on floating rafts is a traditional system in Southern floodplains of Bangladesh (Barisal, Goplaganj and Pirojpur districts). This floating garden is locally known as *Dhap*/*baira*. Farmers construct floating platforms or rafts of reasonable size with local hydrophytic resources like water hyacinth (*Eichhornia crassipes)* and other aquatic weeds and cover with soils. They sow seeds of different vegetables on this soil bed [29]. This is an adaptation to water level rise due to climate change. Different development agencies and the government of Bangladesh have been promoting it in other parts of the country. Department of Agriculture is extending it for rice seed bed preparation in flood affected areas.

3.7. Fisheries

3.7.1. Traditional fish sanctuaries: *Kata*/*Kua*

This is a temporary fish park set in freshwater wet land in the country for preserving fish seasonally in a particular area. People can identify the right site of fish assemblage of fish and demarcate the area by putting bamboo posts. Then they put brush wood piles in that area for fish conservation. In most of the areas this is locally called *kata* or *kua*. This is a good mode of fish conservation. In the past decades this has been linked at project level and many fish sanctuaries have been established throughout open water ecosystem in the country. Farmers have knowledge about brushwood species, like: *Streblus asper, Tamarindus indica, Pongamia pinnata, Barringtonia acutangula* etc. [25].

3.7.2. Small scale rice-fish production

This is a traditional system practiced in many parts of Bangladesh. In this traditional culture system farmers generally dig several small ditches in the rice fields and put tree branches or bushes to make artificial habitat to attract wild fishes [24].

3.8. Disaster management

3.8.1. Traditional homestead protection from wave erosion (*tafal*) in haor areas

Bamboo pole fences tied with strings against soil mounds in angels leaving space between the bamboo fence and the soil mound. The gap is filled up with *chilla* grass that does not rot under submerged condition. It is locally called *Aar Bandha* and also called *chailla deoa*. Community labors are involved and based on local resources [29].

3.9. Food processing and preservation

3.9.1. Indigenous food preservation through sun drying

Consumption of dry fish is part of food culture in many parts of Bangladesh. People have the practice of fish preservation through sun drying. The dry fish is a commercial commodity in Bangladesh and it ensures protein security in lean natural fishing periods. In many open water fisheries areas it is a conventional practice and a commercial enterprise.

In hill areas vegetables preservation through sun drying is a common traditional system. Generally, women process many vegetables and foods like radish, bamboo shoots through slicing sundry them to preserve for the rainy season [32]. Storage and preservation of many fruits like jujube, tamarind and many medicinal herbs are also practiced. This ensures food security and cash generation during lean periods.

3.9.2. Salting of hilsha fish

There is tradition of preserving sliced *hilsha* fish by salt in many parts of the country.

3.9.3. Pickles

Preserving fruits as pickles in different ways is an age-old practice in Bangladesh. Generally, fruits are preserved as pickles in brines or thick sugar syrups or in mustard oils [33].

4. Discussions

It is evident from the review that in Bangladesh many TEKs are still use in practice in production systems like agriculture, tree production, fisheries, livestock, disaster management etc. These all ensures food security, health care, livelihoods and climate change vulnerabilities. TEKs described here are limited to some locality specific production systems. TEKs from many other production systems and commodities are not described or recorded. Most of the practices are locality specific. Never the less, people from different parts of Bangladesh are still practicing indigenous methods and these have different degrees of positive impacts on natural resources management. The practices are centered on ecosystems, their services, biological resources (both plants and animals), their uses, value addition processes and conservation. In totality a management system is operative in the ecosystems and their components.

TEK is now shrinking at an alarming rate due to urbanization, market influence, population increase, land use changes, out migration of young generation to urban areas, access to the modern facilities and overall reluctance of the young generation for this un-codified knowledge system. The United Nations has declared the decade 2021–2030 as *UN Decade of Ecosystem Restoration* (2021–2030) to halt and reverse the degrading ecosystem of the world. Practicing TEKs are milestones towards achieving the declaration. These TEKs play direct roles in achieving *Sustainable Development Goal 15* and also other crosscutting issues. At the 2016 The World Conservation Congress in 2016 adopted a resolution (WCC-2016-Res-069) which, for the first time, defined the use of nature for simultaneous benefits to biodiversity and human well-being as *Nature-based Solutions (NbS).* The practicing TEKs are in fact the existing *NbS* towards conservation of nature and biodiversity. Thus, the practice of TEKs is playing active roles in meeting the demands of these global development agenda.

5. Conclusion

TEKs being informal are transferred orally from generation to generation and not codified under any formal discipline. Information so far recorded is fragmentary. To

make use of this knowledge system the practices are need to be kept viable. Also, the lost ones need to be revived. It needs a collaborative effort so that it does not get further lost and to make it perpetuated. UNESCO's Local and Indigenous Knowledge Systems programme (LINKS) promotes local and indigenous knowledge and its inclusion in global climate science and policy processes. LINKS strives to strengthen indigenous peoples and local communities, foster trans-disciplinary engagements with scientists and policy-makers and pilot novel methodologies to further understandings of climate change impacts, adaptation and mitigation [34].

Our young generations need to be enlightened with this knowledge system. So we need to incorporate this knowledge system into school curricula. In addition, universities and research organizations should collaborate with governments to systematically collect codify and document all forms of TEK for the current and future generations. These could be adopted in local development planning process. Furthermore, these attributes need to be mainstreamed in developing local level natural resource utilization and management plan. One of the approaches could be adoption of best practices [10].

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Consent to participate: No individual participants or material were involved in the research presented in this paper and, thus, there is no need to obtain informed consent.

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