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Plant biodiversity and ethnobotany inside the projected impact area of the Upper Seti Hydropower Project, Western Nepal

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Abstract A survey of plant biodiversity and ethnobotany was conducted along the Seti river banks in the Tanahun district of Western Nepal. This area, home of the *Magar* ethnic group, will be impacted by a major hydropower project, currently under feasibility study. The objective of the study was to document plant biodiversity and ethnobotany in order to suggest appropriate conservation and management strategies. Botanical sampling was conducted inside quadrats and along transects. A total of 221 plant species were recorded in the study area, distributed as herbs (80 species), trees (68), shrubs (28), climbers (19), pteridophytes (18), lianas (5), and epiphytes (3). Twelve of the inventoried species figure in one or more conservation categories identified by various national or international agencies. Group discussions and personal interviews allowed to find out that 43% of the species were ethnobotanically important for the local people and that most were used as medicine, food, or timber. We propose specific species for sustainable use programs based on certain criteria. The area is very important in terms of plant biodiversity and ethnobotany, and hence, immediate implementation of conservation measures is recommended to maintain the high social, ecological and economic values of the area.

Keywords Conservation and management · *Magar* ethnic group · Non-timber forest products · Nepal · Species diversity

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1 Introduction

Biodiversity is highly significant for securing different fundamental human needs (Ehrlich and Ehrlich 1992; Carpenter et al. 2006; Diaz et al. 2006; Kaimowitz and Douglas 2007; Lachungpa 2009). Since time immemorial, people have gathered plant resources to fulfill various needs. Hundreds of millions of people, mostly in developing countries, derive a significant part of their subsistence and income from gathered plant products (Schippmann et al. 2002). Indigenous knowledge systems associated with various plant uses have become recognized worldwide for their contribution to science and conservation (e.g., Gemedo-Dalle et al. 2005; Leduc et al. 2006; Martinez et al. 2006; Kunwar and Bussmann 2008; Albuquerque et al. 2009; Dahlberg and Trygger 2009), and the need to preserve biological diversity and the associated indigenous knowledge has been emphasized since the Rio Convention on Biological Diversity (Convention on Biological Diversity 1992).

In Nepal, knowledge related to biological diversity is mostly found in ethnic groups (Manandhar 2002; Shrestha et al. 2004; Uprety et al. 2008, 2010a, b). This knowledge could prove very useful for sustainable, integrated resource management (Saxena et al. 2001). Conservation of forest ecosystems in Nepal is increasingly challenged by the rising demand for energy, prompting the construction of major hydropower infrastructure (Pokharel 2001; Bartle 2002). However, potential impacts of hydropower development on biodiversity and associated traditional activities (e.g., gathering of medicinal plants) have received little attention.

Environmental impact assessment (EIA) is one of the main instruments available to ensure the sustainability of development projects. EIA involves the systematic identification and evaluation of the possible impacts of proposed development projects on every aspects of the environment (Bhatta and Khanal 2009). The potential role of EIA in achieving the objectives of sustainable development was recognized in the Rio Convention on Biological Diversity (Convention on Biological Diversity 1992). EIA is mandatory for signatory countries, which have to include appropriate biodiversity conservation procedures in developmental projects (Convention on Biological Diversity 1992). In Nepal, the Environment Protection Act (1996) and Regulations (1997) have made Initial Environmental Assessment (IEA) or EIA mandatory in development projects (MoFSC/NCSIP 1995). Nevertheless, EIA provisions have been included in development policies since the 1980s (Bhatta and Khanal 2009).

This study reports on plant species diversity and provides a comprehensive list of plants used by indigenous people living inside the impact area of a projected hydropower site in Western Nepal (Dhungel and Pun 2009). Specific actions are discussed, and species are identified for sustainable use programs. Assuming that the study area harbors rich plant biodiversity and that local people possess sound ethnobotanical knowledge on plant use (Uprety et al. 2010a), this study was undertaken in parallel with the EIA of the upcoming Upper Seti Hydropower Project by documenting expected impacts on biodiversity and subsistence activities. The outcomes of the study will be relevant for a wide range of stakeholders, including government agencies, development- and conservation-oriented organizations, project implementation authorities and local peoples. The paper will also be of interest to the scientific community interested in biodiversity conservation and management and associated traditional knowledge, especially in contexts of large-scale development projects.

2 Study area

The study took place along the banks of the Seti river, which extends 40 km from Bhimad to Damauli in the Tanahun district (27°36′–28°05′ N and 83°57′–84°53′ E) of Western

Nepal (Fig. 1). The Upper Seti Hydropower Project, under feasibility study, is thought to be highly important to fulfill the increasing energy demand and to positively affect the livelihoods of the people living in the area. The population is mainly composed of the *Magar* ethnic group, which is the largest ethnic group in Nepal (Shrestha et al. 2004).

The climate of the study area is tropical, with a mean annual rainfall of 1,761 mm, maximum temperature between 38 and 41°C, and minimum temperature between 5 and 6°C. Rainfall distribution is of monsoon type, with monsoon occurring from June to September. Large-volume rivers, such as the Seti, Kaligandhaki, Madi, Trisuli, and Marsyandi, flow through the Tanahun district and provide high potential sites for hydropower development in the country (GoN 2001).

Total forested area in the Tanahun district is 77,573 ha (GoN 2001). Altitude has an important influence on vegetation distribution, with most vegetation found at lower elevations. Moisture is retained on north and west facing slopes, while south and east faces remain drier due to longer exposure to sun. Except for shrublands and cultivated areas on hilltops, both sides of the Seti river show less disturbed vegetation on steep and inaccessible slopes. The river banks have high biodiversity value due to the presence of threatened plant and tree species, such as Orchidaceae, *Shorea robusta* and *Acacia catechu*.

2.1 Main forest types

2.1.1 Riparian forest

Forests of this type are found on sandy soils of the river banks. The dominant species is *Acacia catechu* and is threatened in the area. The main companion species are *Bombax ceiba*, *Dalbergia sisoo*, *Sapium insigne*, and *Murraya koenigii*.

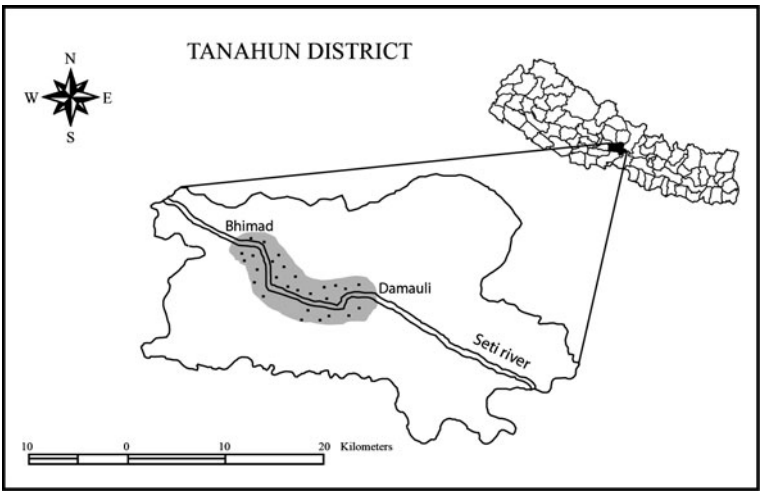

Fig. 1 Study area in the Tanahun district of Western Nepal, indicating the approximate projected impact area of the Upper Seti Hydropower Project (*shaded*), as well as the 27 quadrats where plant biodiversity was assessed

2.1.2 Mixed forest

This forest type is dominant along the river belt and has a rich understory. Representative tree species differ depending on slope aspect. *Terminalia alata*, *Mallotus philippensis*, *Albizia chinensis*, *Albizia lebbeck*, *Sapium insigne*, *Bamboo* spp., *Lagerstroemia parviflora*, *Bauhinia vahlii,* and *Desmodium oojeinense* are commonly found in this forest type. Other associates are *Murraya koenigii*, *Leea macrophylla,* and *Dioscorea bulbifera*.

2.1.3 Hill sal forest

Shorea robusta (sal) is mostly dominant above the flood line of the river (>400 m). Companion species include *Schima wallichii*, *Lagerstroemia parviflora*, *Bauhinia vahlii,* and *Desmodium oojeinense*.

2.2 Community forestry

The Community Forestry (CF) Program in Nepal encompasses a set of policy and institutional innovations that began in the mid 1970s to involve local communities in forest management and conservation and to foster livelihood improvement (Acharya 2002; Ojha et al. 2009). The program, well institutionalized under the Forest Act (1993) and Regulations (1995), is now considered a very successful innovation in forest management, where the Community Forest Users Groups (CFUGs) have rights to decide forest management practices (Acharya 2002). CFUGs prepare a constitution and an operational plan that are evaluated by the District Forest Office (DFO). The forest is handed over to the community by assessing accessibility, traditional use rights, and willingness and capacity to manage (Acharya 2002). Forests of different sizes (from 3 to 300 ha) are managed by CFUGs in the study area.

3 Methodology

3.1 Ethical approval

Prior to undertaking field research, the objectives of the study were discussed with the local government authorities, and permission was obtained from the DFO of the Tanahun district to work in the study area. In the villages where research would be undertaken, prior informed consent was obtained by discussing the objectives of the study with the village heads (Martin 1995; Collins et al. 2006). The purpose of the study was explained, as well as the expected impacts of the hydropower project, such as impacts on human settlement, biodiversity, commercial activities (including commercialization of forest products), and reservoir impoundment and flooding. This information session was very positively received and it encouraged people to take part in the interviews and discussion sessions. Consent was granted by the local people for the dissemination of their traditional knowledge.

3.2 Local flora inventory and ethnobotanical study

The flora of the project area was inventoried twice in two different seasons, first in June–August 2006 (summer) and second in January–March 2007 (winter). Plants were recorded

in quadrats and along transects. Quadrat size was determined using the species area curve method elaborated by Zobel et al. (1987). A total of 27 randomly selected 25 × 25 m quadrats, covering all of the potential impact area of the Upper Seti Hydropower Project, were positioned on both sides of the river to capture variations in forest types due to slope aspect (Fig. 1). Cross-shaped, 5-m-wide transects (parallel and perpendicular to the slope) were established between quadrats to take into account differences in vegetation due to position on the slope. Transects varied in length between 100 and 200 m.

Rapid rural appraisal (RRA) was used to gather, confirm, and validate ethnobotanical information during the first field visit (Martin 1995). In RRA, information is obtained by conducting semi-structured interviews with small groups of people or with individuals. Interview guidelines were elaborated and used for group discussions at the community level, as well as for interviews with key informants (Huntington 2000) such as local healers, family heads, elders, village heads, and community forest heads. Six community-level discussion groups were held in six different localities: Patan, Huksetar, Bandar Kuna, Toonipul, Rising Patna, and Bhimad. An average of seven persons participated in each discussion group, and an additional 18 persons were interviewed individually. A checklist of different plant use categories was developed and used to determine which species were used and for what purposes.

Four to six key informants from each locality who participated in discussion and interview sessions were requested to walk along the botanical inventory transects and to report different vegetation types and useful species. Cunningham (2001) has stressed the importance of transect walks with key informants in biodiversity and ethnobotanical studies. These walks also provided an opportunity to validate the findings of RRA and allowed to gather information about the local names of many plant species. Respondents were asked to mention the perceived threats to local biodiversity, and the responses were validated by cross-discussion with respondents in different localities. Further investigation was performed in the forest, and threats were later discussed with the authorities of the CFUGs and DFO. The conservation status of each species according to national and international agencies was obtained from literature (Shrestha and Joshi 1996; Chaudhary 1998; MoFSC 2002). In cases where field identification of species was certain, for example *Aegle marmelos, Castanopsis indica*, and *Shorea robusta*, herbarium specimens were not collected. In the other cases, field notes and photographs were taken and herbarium specimens were collected. The specimens were identified with the help of reference collections (Hara and Williams 1979; Hara et al. 1982; Polunin and Stainton 1984; Press et al. 2000) and expert knowledge. The specimens are deposited at the Tribhuvan University Central Herbarium (TUCH). Plants were classified into native and exotic categories in accordance with their biogeographical origin.

3.3 Market inventories

Local and regional market inventories were conducted in June–July 2007 to identify potential non-timber forest products (NTFPs) from the study area that had commercial value. The main trading centers for NTFPs (herb traders, street markets, and fruit shops) were surveyed to collect information about the commercial value of NTFPs and their use to sustain livelihood through income generation (FAO 1995; Mbuvi and Boon 2009).

3.4 Prioritization of plant species

Medicinal and edible plant species were ranked according to prioritization criteria (CECI 2006). Criteria accounting for bulkiness (availability in large quantities), local knowledge

and use, and commercial value were given more weight (Uprety et al. 2010a). Data obtained were triangulated (Jick 1979) to ensure reliability and validity during the interviews and discussion sessions. The following prioritization criteria were used:

- Market value/price
- Quantity exported annually, as recorded by the DFO
- Average annual export
- Annual industrial demand in Nepal
- Ease of cultivation/domestication
- Royalties
- Parts used
- Bulkiness (availability in large quantities)
- Availability of local processing techniques
- Potential for further processing
- Social acceptance for further processing
- Quality improvement
- Distribution range
- Threat category
- Legal protection
- Regeneration/rotation period
- Ethnobotanical importance

4 Results

4.1 Plant biodiversity and ethnobotany

A total of 221 plant species (203 Angiosperms and 18 Pteridophytes) were inventoried (Appendix). Angiosperms belonged to 67 families and 163 genera and were distributed into different life forms, with herbs and trees having the most species (Fig. 2). Well-represented angiosperm families were Leguminosae (20 species), Gramineae (17), Euphorbiaceae (12), Moraceae (10), Solanaceae (8), Compositae (8), Labiatae (7), and Verbenaceae (7). Species richness ranged from 16 to 28 species per 25 × 25 m plot. The most frequent species were *Murraya koenigii* (70%), *Dioscorea* spp. (51%), *Acacia catechu* (45%), *Mallotus philippensis* (34%), and *Shorea robusta* (23%). Three threatened species were found to be dominant in some stands (*Acacia catechu*, *Dioscorea* spp., and *Shorea robusta*). However, except for *Bombax ceiba* (14% frequency), other species listed in various conservation categories were encountered only once along transect walks. Furthermore, none of these species was recorded in the study plots. Of the 18 Pteridophyte species recorded, 10 were from the Pteridaceae family, two each from the Schizaeaceae and Aspidiaceae families, and one each from the Davilliaceae, Dryopteridaceae, Equisetaceae, and Selaginellaceae families.

Among the 221 inventoried plant species, 96 (43%) were documented to be used for various purposes by the *Magar* ethnic group. These plant species belonged to 52 families and 81 genera and their respective uses are documented in the "Appendix". Families with the most species used were Leguminosae (10 species), Euphorbiaceae (8), Moraceae (7), Gramineae (7), and Compositae (5). Most species were collected in the wild. Exceptions were *Ananas comosus, Artocarpus integra, Maesa macrophylla,* and *Mangifera indica,*

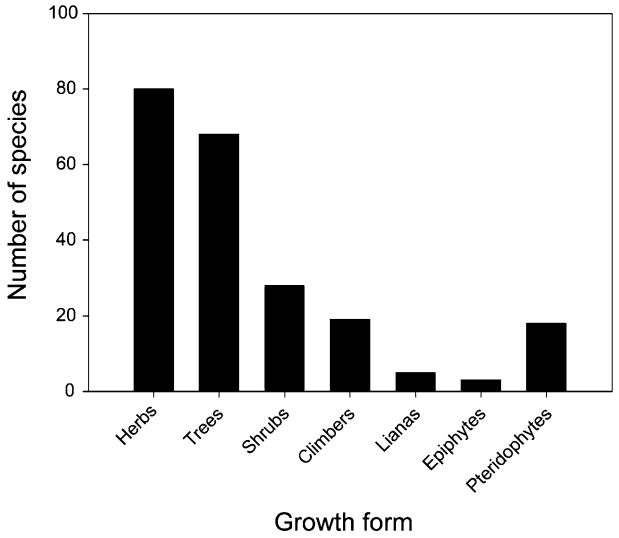

Fig. 2 Diversity of plant growth forms in the study area

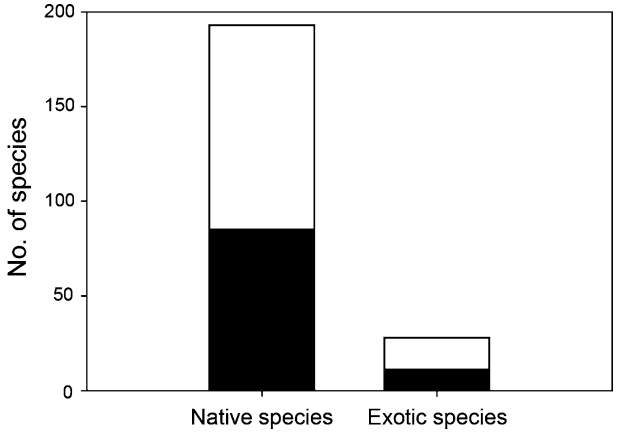

Fig. 3 Exotic and native species richness and use (*black* used, *white* not used)

which were cultivated in home gardens. Exotic species accounted for 11% of the species used by the local people (11/96) and 13% of the inventoried species (28/221) (Fig. 3).

4.2 Major use categories

People from the *Magar* ethnic group used plants for multiple purposes (Fig. 4). Medicinal (54 species), food (29), and timber (17) were the most frequent plant uses (Fig. 4). Among the 96 plant species used by the *Magar* people, most were only used for one (64/96) or two (25/96) purposes. Species used for three or more purposes were *Bauhinia vahlii*, *Castanopsis indica*, *Desmodium oojeinense*, *Eulaliopsis binata*, *Ficus semicordata*, *Schima wallichii*, and *Shorea robusta*.

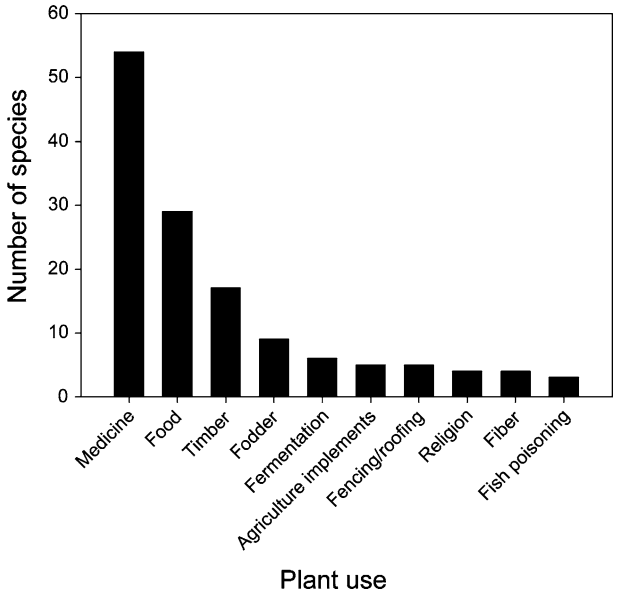

Fig. 4 Diversity of plant use in the study area

A total of 54 plant species, distributed into 38 families, were used for medicinal purposes (24% of the total flora and 56% of used plants). Leaves and roots were the most frequently used plant parts. The most frequent type of preparation was juice (70% of all preparation methods) (Table 1). Medicinal plants were used to treat 13 different ailments (Table 1, Fig. 5).

Twenty-nine plant species belonging to 19 families and 25 genera were identified as edible by the local people (Table 2). Fruits and shoots were the most frequently eaten parts. *Aegle marmelos*, *Morus nigra*, *Rubus ellipticus*, *Syzygium cumini*, and *Zizyphus rugosa* were commonly consumed by the herders while spending time in the forest. Species such as *Dioscorea bulbifera*, *Dioscorea deltoidea*, *Tectaria macrodonta*, and *Urtica dioica* were common food sources, providing dietary requirements like fibers, iron, and calcium. Some of the species consumed as fruits or vegetables also possessed medicinal properties and were identified as medicinal plants, e.g. *Aegle marmelos*, *Asparagus racemosus*, *Phyllanthus emblica*, *Syzygium cumini*, and *Zizyphus rugosa.*

Nine plant species belonging to six families were highly preferred for fodder. All fodder species were trees, except *Bauhinia vahlii* (liana). *Ficus racemosa*, *Ficus sarmentosa*, *Bauhinia vahlii*, and *Garuga pinnata* were highly preferred fodder species. According to the local people, these species are very nutritive and enhance milk production.

Different species in the area were used for various other purposes (Appendix). Fermentation—a practice involved in wine brewing—is one of the important cultural, social, and religious activities of the *Magar* ethnic group. Species used for fermentation were *Ananas comosus*, *Artocarpus integra*, *Clerodendrum indicum*, *Piper longum*, *Saccharum officinarum*, and *Sonchus wightianus*. The paste extracted from the leaves of *Maesa macrophylla* and *Sapium insigne,* as well as the bark of *Schima wallichii*, was reported to be used for fish poisoning.

Table 1 Medicinal plants used by the local people of the Tanahun district, Western Nepal

S. No	Species name	Local name	Part(s) used	Purpose
1.	*Acacia catechu**	Khayar	Stem	Juice drunk against body and stomachache.
2.	*Acorus calamus**	Bojho	Root	Chewed against cough.
3.	*Aegle marmelos**	Bel	Fruit, Bark	Fruit pulp and bark juice used against diarrhea and stomachache.
4.	*Ageratum conyzoides*	Gande	Leaf	Juice applied on cuts and wounds.
5.	*Alstonia scholaris**	Chhatiwan	Stem	Latex applied on sprain.
6.	*Artemisia indica**	Titepati	Leaf	Juice applied on cuts and wounds and boils.
7.	*Asparagus racemosus**	Kurilo	Root	Juice used as a laxative.
8.	*Artocarpus lakoocha*	Badahar	Bark	Juice drunk against stomachache.
9.	*Azadirachta indica**	Neem	Leaf	Infusion drunk for body cooling and against toothache, malarian fever, and diarrhea.
10.	*Bauhinia variegata**	Koiralo	Bark	Juice mixed with juice of *Mangifera indica* and *Aegle marmelos* used against diarrhea. Juice also drunk for body cooling.
11.	*Begonia tribenensis*	Makarkache	Whole plant	Juice drunk against stomachache.
12.	*Boehmeria rugulosa*	Githa	Leaf	Paste applied on wounds.
13.	*Calotropis gigantea*	Aank	Stem	Latex applied on sprain.
14.	*Cannabis sativa*	Ganja	Leaf	Paste used for stomach problems.
15.	*Centella asiatica**	Godtapre	Whole plant	Juice drunk against fever, urinary tract infection, or for body cooling.
16.	*Cheilanthes dalhosiae*	Ranisinka	Whole plant	Juice drunk against stomachache.
17.	*Cissampelos pareira**	Batulpate	Root	Juice drunk against stomachache.
18.	*Clerodendrum indicum*	Rudilo	Leaf	Juice drunk against fever, headache, cold, and cough.
19.	*Cuscuta reflexa*	Akasbeli	Whole plant	Juice drunk against jaundice.
20.	*Drymaria diandra*	Abijalo	Leaf	Juice drunk against fever.
21.	*Elephantopus scaber*	Sahasrabuti	Root	Juice taken for body cooling.
22.	*Ensete glaucum*	Bankera	Root	Juice drunk against urinary tract infection.
23.	*Erythrina stricta*	Phaleto	Bark	Juice taken for body cooling.
24.	*Eulaliopsis binata*	Babiyo	Young leaves	Paste applied on bone fracture.
25.	*Eupatorium adenophorum*	Banmasa	Leaf	Juice applied on cuts.
26.	*Euphorbia hirta*	Dude	Leaf	Juice applied on cuts.
27.	*Ficus semicordata*	Khaniyo	Root	Juice drunk against urinary tract infection.
28.	*Jatropha curcas**	Sajiban	Stem	Juice and latex applied on cuts and wounds.
29.	*Mallotus philippensis**	Rohini	Seed	Decoction drunk against stomachache and for body cooling.
30.	*Mangifera indica**	Aanp	Bark	Decoction and juice drunk against stomachache and rheumatism.
31.	*Michelia champaca**	Champ	Leaf	Paste applied on bone fracture.
32.	*Mimosa pudica**	Lajjawati	Root	Juice drunk for body cooling.

Table 1 continued

S. No	Species name	Local name	Part(s) used	Purpose
33.	*Morus nigra**	Kimbu	Root	Juice drunk against worms.
34.	*Mussaenda macrophylla*	Dhobini	Root	Juice drunk against fever.
35.	*Myrica esculenta**	Kafal	Bark	Decoction drunk against blood dysentery or bleeding from teeth.
36.	*Oxalis corniculata*	Chariamilo	Whole plant	Juice drunk against fever.
37.	*Phyllanthus emblica**	Amala	Fruit	Chewed against cough and cold.
38.	*Piper longum**	Pipla	Fruit	Chewed against cough.
39.	*Premna barbata**	Gineri	Leaf	Juice drunk against headache.
40.	*Rubus ellipticus*	Aiselu	Root	Juice drunk against urinary tract infection.
41.	*Saccharum spontaneum*	Kans	Root	Paste mixed with powder of *Mallotus philippensis*, fruit powder/paste of *Piper longum,* root juice of *Tinospora cordifolia* and root juice of *Cheilanthes dalhosiae* against stomachache.
42.	*Shorea robusta**	Sal dhup	Stem	Latex used against blood dysentery.
43.	*Solanum surattense**	Kantakari	Fruit	Smoked against toothache.
44.	*Spondias pinnata*	Amaro	Bark	Paste applied on rheumatism.
45.	*Syzygium cumini**	Jamun	Bark	Juice drunk against cough, headache and sinusitis.
46.	*Tectaria macrodonta*	Kali neuro	Rhizome	Juice drunk against blood dysentery.
47.	*Terminalia bellirica**	Barro	Fruit	Pulp used against cough.
48.	*Terminalia chebula**	Harro	Fruit	Pulp used against cough.
49.	*Thespesia lampas*	Ban kapas	Whole plant	Paste and juice applied to cut and wounds, sprain and bone fracture.
50.	*Tinospora cordifolia**	Gurjo	Stem	Juice applied on sprain and drunk for body cooling.
51.	*Vanda teres*	Goya	Fruit	Pulp applied to bone fracture.
52.	*Viscum album*	Hadchur	Leaf	Paste applied to bone facture.
53.	*Woodfordia fruticosa**	Dhairo	Flower	Juice drunk against stomachache.
54.	*Zizyphus rugosa*	Bayar	Seed, root	Juice drunk against stomachache, for body cooling, and also effective against smallpox.

Species identified by an asterisk have commercial value

4.3 Commercial value and prioritization of NTFPs

A market survey conducted for 70 of the 96 species that were of ethnobotanical importance (timber and fodder species were excluded) showed that many species possessed commercial value (Tables 1, 2). Species with market value accounted for 65% of the species used by the local people and 21% of the flora inventoried in this study. Furthermore, fibers from *Bauhinia vahlii* and *Eulaliopsis binata* were used for weaving ropes that were sold locally. *E. binata* was also used in the paper manufacturing industry.

After consultation with the local people, DFO, and community development organizations, 12 medicinal and 10 edible plants were given high priority because of their

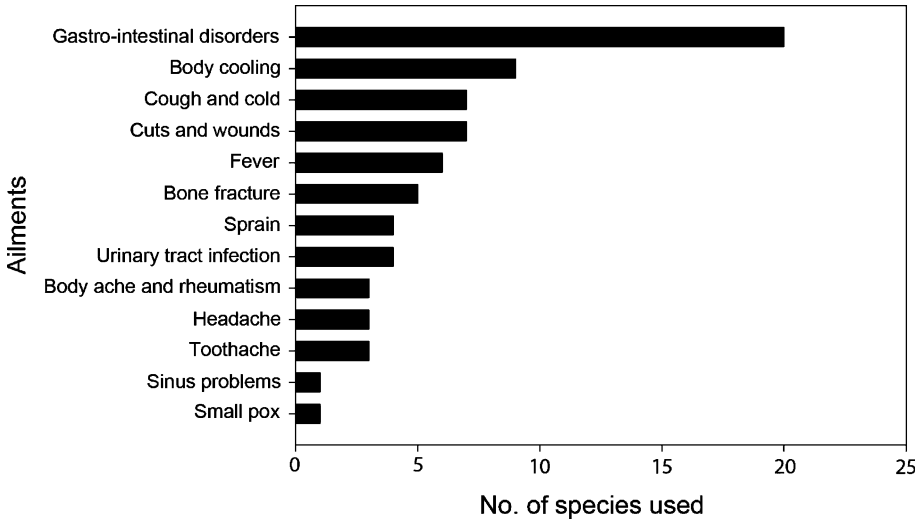

Fig. 5 Number of species used to treat different ailments

potential commercial value (Tables 3, 4). Four species were in both lists: *Asparagus racemosus*, *Morus nigra*, *Myrica esculenta*, and *Phyllanthus emblica*.

4.4 Threats and conservation issues

Immediate threats to plant biodiversity in the study area were rapid expansion of agricultural lands, habitat destruction, over-harvesting of timber species, over-grazing, and, in some areas, replacement by invasive species. If the Upper Seti Hydropower Project is realized, several highly diverse riparian forests and ecosystems will be flooded. Plant biodiversity is important locally, and medicinal and edible plant species are at risk of overexploitation, especially if the area where they are harvested is substantially reduced by impoundment of a large hydropower reservoir.

Formalized forest policy and regulations embodied in Nepal's Forest Act (1993) and Regulations (1995) describe the ways in which forests should be managed and resources collected. However, apart from these legal provisions, existing conservation practices were very limited in the area. Most forests were under Community Forest User Groups licenses. A total of 18 community forests had management plans approved by the DFO. Some forest areas were managed by the DFO, whose priority is commercial exploitation of timber species. No mention was made in the management plans of community forests about sustainable use of NTFPs like medicinal and edible plants. There were no practices of NTFP culture or processing. Nevertheless, the local people considered collection and sale of species having potential commercial value.

The study area harbored rare, endemic and threatened species. Twelve of the inventoried species figured in one or more conservation categories identified by various agencies: Government of Nepal (GoN), Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), and World Conservation Union (IUCN) (Table 5). Of the 12 species under one or more conservation status, 8 were used by indigenous people, mostly for medicinal purposes. *Begonia tribenensis,* an endemic

Table 2 Edible plants used by the local people of the Tanahun district, Western Nepal

S. no	Species name	Local name	Part(s) used	Purpose
1.	*Aegle marmelos**	Bel	Fruit	Fruit
2.	*Asparagus racemosus**	Kurilo	Young shoot	Vegetable
3.	*Bambusa nepalensis**	Choya bans	Young shoot	Vegetable
4.	*Bauhinia vahlii*	Bhorla	Fruit	Fruit
5.	*Bauhinia variegata**	Koiralo	Flower	Pickle
6.	*Castanopsis indica**	Katus	Fruit	Fruit
7.	*Cleome viscosa*	Ban tori	Seed	Spice
8.	*Coccinia grandis*	Gol kakri	Fruit	Fruit
9.	*Crateva unilocularis**	Sipligan	Young shoot	Vegetable
10.	*Dioscorea bulbifera**	Githa	Fruit	Vegetable
11.	*Dioscorea deltoidea**	Tarul	Tuberous root	Vegetable
12.	*Ensete glaucum*	Ban kera	Fruit	Fruit
13.	*Ficus racemosa*	Dumbre	Fruit	Fruit
14.	*Ficus sarmentosa*	Bedulo	Fruit	Fruit
15.	*Ficus semicordata*	Khaniyo	Fruit	Fruit
16.	*Momordica dioica*	Ban karela	Fruit	Vegetable
17.	*Morus nigra**	Kimbu kafal	Fruit	Fruit
18.	*Myrica esculenta**	Kafal	Fruit	Fruit
19.	*Nephrolepis cordifolia*	Paniamala	Tuberous root	Fruit
20.	*Phyllanthus emblica**	Amala	Fruit	Fruit
21.	*Remusatia vivipara**	Jaluko	Tender shoot	Vegetable
22.	*Rhus javanica*	Bhakmilo	Fruit	Fruit
23.	*Rubus ellipticus**	Aiselu	Fruit	Fruit
24.	*Smilax ovalifolia*	Kukurdaino	Young shoot	Vegetable
25.	*Spondias pinnata*	Amaro	Fruit	Fruit
26.	*Syzygium cumini**	Jamun	Fruit	Fruit
27.	*Tectaria macrodonta**	Kali neuro	Young shoot	Vegetable
28.	*Urtica dioica*	Sisnu	Young shoot	Vegetable
29.	*Zizyphus rugosa**	Bayer	Fruit	Fruit/Pickle

Species identified by an asterisk have commercial value

tuberous herb of Nepal, was reported for the first time in the Tanahun district, near the confluence of the Seti and Madi rivers.

5 Discussion

5.1 Plant biodiversity and species richness

Species richness in the study area could be considered moderate to high if compared to what was reported for comparable habitats in India (Kadavul and Parthasarathy 1999). Euphorbiaceae, a family that was well represented in the Tanahun district, was also dominant in India (Kadavul and Parthasarathy 1999). Distribution of species into different life forms followed a pattern similar to what was reported by Bhattarai and Vetaas (2003)

Table 3 Priority medicinal plant species for the Tanahun district of Western Nepal

Rank	Prioritization score (/50)	Species name
1	44	*Phyllanthus emblica* L.
2	41	*Jatropha curcas* L.
3	36	*Artemisia indica* Willd.
4	34	*Myrica esculenta* Buch.-Ham. ex D.Don
5	34	*Morus nigra* L.
6	31	*Tinospora cordifolia* (Willd.) Miers.
7	26	*Asparagus racemosus* Willd.
8	25	*Piper longum* L.
9	21	*Shorea robusta* Gaertn
10	20	*Solanum surattense* Burm.f.
11	16	*Acorus calamus* L.
12	15	*Premna barbata* Wall. ex Schauer

Table 4 Priority edible plant species for the Tanahun district of Western Nepal

Rank	Prioritization score (/50)	Species name
1	46	*Dioscorea deltoidea* Wall. ex Griseb
2	43	*Tectaria macrodonta* (Fee) C. Chr.
3	40	*Bauhinia variegate* L.
4	36	*Phyllanthus emblica* L.
5	35	*Bambusa nepalensis* Stapleton
6	31	*Myrica esculenta* Buch.-Ham. ex D.Don
7	28	*Asparagus racemosus* Willd.
8	26	*Zizyphus rugosa* Lam.
9	22	*Morus nigra* L.
10	20	*Rubus ellipticus* Sm.

for eastern Nepal. The dominant species recorded in the present study were also reported to be dominant elsewhere in Nepal (Chaudhary 1998).

5.2 Plants and people

There is an intimate relationship between biodiversity, ecosystem functioning and ecosystem services (Robinson 1993; Salafsky and Wollenberg 2000; Carpenter et al. 2006). Biodiversity is crucial to fulfill human needs and it thus needs careful assessment, conservation and management (Convention on Biological Diversity 1992). In the developing world, livelihood is strongly linked to natural resources extraction and use (Ramakrishnan 2007). Plants have always been a central part of the life and culture of the Nepalese people (Manandhar 2002), and all aspects of the Nepalese folklife and beliefs are related to flora (Shrestha et al. 2004). This study showed an important contribution of plant biodiversity in meeting people's daily needs, as 43% of the inventoried flora was used by the local people in the Tanahun district of Western Nepal. A comparable study conducted in Ethiopia found 49–76% of the flora was used by the local people (Gemedo-Dalle et al. 2005). Unlike the

Table 5 Plants of the Tanahun district recognized by conservation authorities

S. no	Species	Conservation agencies		
		NG*	CITES	IUCN
1.	*Acacia catechu*	+		Threatened
2.	*Alstonia scholaris*			Rare
3.	*Bombax ceiba*	+		
4.	*Coelogyne flaccida*		Appendix II	
5.	*Dendrobium formosum*		Appendix II	
6.	*Dioscorea deltoidea*		Appendix II	Threatened
7.	*Habenaria commelinifolia*		Appendix II	
8.	*Michelia champaca*	+		Endangered
9.	*Oroxylum indicum*			Vulnerable
10.	*Rauvolfia serpentina*	+	Appendix II	Endangered
11.	*Shorea robusta*	+		
12.	*Vanda teres*		Appendix II	

Data from Shrestha and Joshi (1996), Chaudhary (1998), and Ministry of Forest and Soil Conservation (MoFSC) (2002)

NG Nepal Government, *CITES* Convention on International Trade in Endangered Species, *IUCN* World Conservation Union

* Species protected under the Nepal Government Forest Act are shown by a +

present study, Gemedo-Dalle et al. (2005) included herbaceous forage species in their inventory, explaining the higher percentages they obtained.

Most plants were used as medicine or food, as previously observed in other areas of Nepal (Shrestha et al. 2003; Uprety et al. 2008), as well as in Brazil (Rossato et al. 1999), Ethiopia (Gemedo-Dalle et al. 2005), China (Weckerle et al. 2006), or Kenya (Mbuvi and Boon 2009), for example. Medicinal use of plant biodiversity is important for most indigenous rural people (e.g. Coe and Anderson 1996; Heinrich et al. 1998; Rossato et al. 1999; Kala et al. 2004; Dahlberg and Trygger 2009). Although herbs are often found to be the most used plant types for medicinal purposes because of their abundance (Shrestha and Dhillion 2003; Uprety et al. 2010a), trees were the primary source of medicines in the Tanahun district of Western Nepal, highlighting regional variability in resource use. Nine plant species were used for body cooling in the Tanahun district (Table 1), and all were new records (Manandhar 2002). There were no previous records of plants used for this purpose in other ethnobotanical studies conducted in warm environments (Joshi and Joshi 2000; Gemedo-Dalle et al. 2005; Teklehaymanot and Giday 2007; Ragupathy et al. 2008). These species are very important for people working on farms or in the forest, as temperature in the district can reach 41°C in summer (GoN 2001).

Food was the second most important use of wild plant species in the study area. Herders were found to be more knowledgeable about wild edible plants, as they spent a lot of time in the forest with livestock. For most species, fruits were eaten, or the entire plant as a vegetable. The diversity in wild species allowed for variety in family diet and contributed to household food security (Balemie and Kebebew 2006). Wine brewing is an important cultural, social and religious activity, and nine plant species were used for this purpose in the Tanahun district, like in other regions of Nepal (Mueller-Boker 1993; Shrestha et al. 2003). Similarly, some of the plants used for fish poisoning were also commonly used in

other regions (Shrestha et al. 2003). As local livelihood is dependent on agriculture, tree species used as fodder were also important in the region. Improving livestock production could increase food security and enhance local livelihood (Gemedo-Dalle et al. 2005).

The ethnobotanical information presented here is comparable to what was previously reported for other areas of Nepal (Mueller-Boker 1993; Rajbhandari 2001; Manandhar 2002; Shrestha et al. 2003). This is of significance because an identical use of a plant by different people from different areas may be a reliable indication of effective properties (Shrestha and Dhillion 2003; Rokaya et al. 2010; Uprety et al. 2010a).

5.3 Potential economic species

Many of the species recorded in this study possessed economic potential and could thus supplement family income (Carvalho 2004) and generate incentives for biodiversity conservation (Hamilton 2004). However, local people are mostly unaware of the species' economic value. Nevertheless, species prioritized in this study (Tables 3, 4) have high commercial value and reflect the interests of local people, community developmental organizations, and DFO. The prioritized species would be suitable for the development of sustainable use programs contributing to rural income (FAO 1995; Mbuvi and Boon 2009; Uprety et al. 2010b), but the impact of reservoir impoundment on plant availability would need to be assessed. *Jatropha curcus*—exotic but widely naturalized in Asia—is promoted for biodiesel production (Achten et al. 2008) and, as it was abundantly available in the region, it could be exploited on a sustainable basis.

5.4 Conservation issues and possible impacts of the hydropower project

Plant biodiversity is facing different threats from human activity in the study area. Overgrazing, agricultural expansion, fuel wood collection, and timber harvesting were found to be important threats, confirming previous findings (Chaudhary 1998). However, few species benefit from a protection status (Table 5) and it is urgent to remedy this situation. For example, Shrestha (1994) identified *Pandanus nepalensis* as a threatened plant species of wetland habitats, but it is not listed by CITES or IUCN. Invasive species observed in the area (*Eupatorium adenophorum*, *Lantana camera,* and *Parthenium hysterophorus*) have the ability to rapidly establish, thrive and dominate in new and disturbed places and will likely lead to faster replacement of the native species (Yan et al. 2001; Kadavul and Parthasarathy 1999). As the Upper Seti Hydropower Project would create disturbed habitats, colonization by invasive species could occur.

The presence of *Begonia tribenensis*—an endemic species—and many other species in various conservation categories confirms the plant richness and the conservation value of the Tanahun district. The conservation of rare, endangered, and endemic plant populations is an important dimension of biodiversity preservation (Shrestha and Joshi 1996; Chaudhary 1998; Bevill and Louda 1999). Nevertheless, species that are abundant outside the projected impact area may require least concern (Samant et al. 2007).

The Himalayas, being one of the youngest lands on earth, are highly susceptible to landslides, flooding, and erosion (Mani 1978; Sunuwar et al. 2005). If the Upper Seti Hydropower Project is realized, the 140-m-high reservoir will flood several highly diverse riparian habitats. Riparian forests in this area comprise highly threatened plants like *Acacia catechu*, *Bombax ceiba*, *Pandanus nepalensis,* and *Shorea robusta.* The fragile landscapes of the steep V-shaped hills on both sides of the Seti river are likely to be affected by

landslides destroying many forest patches and the associated high biodiversity moist habitats.

At present, the dependency of local people on biodiversity is high. The possible impoundment of the forest and shifting of human settlement would probably increase pressure on residual forest patches. However, the hydropower project could transform the lifestyle of the people and decrease dependency on local biodiversity. In any case, reservoir impoundment will likely result in a loss of knowledge about plant species and their multiple uses. Such knowledge is not only culturally important, but has been shown to complement scientific knowledge for effective biodiversity conservation (Millat-e-Mustafa et al. 2000; Boon and Hens 2007).

5.5 Proposals for biodiversity conservation

Indigenous communities have developed sustainable natural resource management systems over many generations based on a holistic knowledge of the land (Cunningham 1993; Singhal 2000). In recent years, applied ethnobotanical research has not only been used to determine how local people use plant resources, but also to improve conservation and management of plant biodiversity (Ghimire et al. 2004; Hamilton 2004; Albuquerque et al. 2009). Therefore, mechanisms to ensure local people participation in planning and implementation of management and development projects should be improved, and the success story of community forestry implementation in Nepal (Acharya 2002) could be repeated elsewhere with inclusive programs for sustainable management of timber and non-timber forest products.

By showing interactions between plants and people, this study could help to implement a framework for the sustainable conservation and management of plant biodiversity. Given that local livelihood and income generation activities are mostly based on plant resources, the sustainable use and commercialization of NTFPs could provide important incentives for biodiversity conservation (Fig. 6). However, the process will need defined legal frameworks, capital input, appropriate technology transfer, and, most importantly, community participation at all levels of decision making.

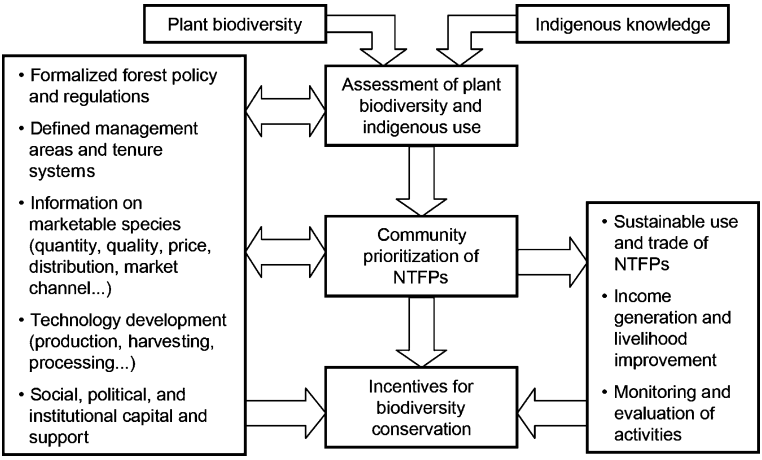

Fig. 6 Framework for biodiversity conservation in the Tanahun district

Based on interviews and field observations conducted in the projected impact area of the Upper Seti Hydropower Project, we propose a framework (Fig. 6) that will require active participation of various stakeholders involved in conservation and development (Uprety et al. in press). Government agencies will have to formalize forest policy and regulations, propose well-defined tenure systems, and provide support for the development of social, political, and institutional capital. Conservation- and development-oriented organizations, together with government agencies, will have to provide technical inputs to help technology development. They will also have to foster community mobilization in biodiversity assessment and identification of potential NTFPs. This latter role will be of significant importance considering the limited human and financial resources of government agencies. The integrated approach will promote sustainable use of NTFPs and contribute to income generation and livelihood improvement for local people. These outcomes will occur whether the hydropower project is realized or not. If the project is indeed realized, implementation authorities will have to adopt mitigation measures to minimize species loss. Monitoring and evaluation measures will also have to be put into place. These measures will have to consider the local populations' viewpoint. While government agencies and project implementation authorities will certainly be involved in monitoring and evaluation, third-party organizations will play a key role in assuring objectivity and neutrality. The combined roles of all stakeholders will help safeguard biodiversity components and associated traditional knowledge, thus favoring the social, economic and ecological sustainability of development activities.

6 Conclusion

The projected impact area of the Upper Seti Hydropower Project possesses high-value ecosystem services that are worth being preserved for their contribution to livelihood improvement and income generation. Despite the many challenges posed by anthropogenic disturbances, sustainable resource management and biodiversity conservation can be conciliated, providing opportunities for social, ecological, and economic benefits. Reaching a balance between development and conservation should be a priority for the authorities responsible for development projects such as the Upper Seti Hydropower Project. Meanwhile, identifying proper management options and conservation areas, as well as mitigation measures, will help minimize species loss due to dam construction and reservoir impoundment. The assessment of plant biodiversity and ethnobotanical knowledge presented here will help estimate the ecological vulnerability of the region. Further assessment of the abundance of threatened and culturally important species outside the projected impact area is necessary to establish conservation priority. Plantation of culturally important species and domestication in home gardens could also be investigated as possible means of helping local people to maintain traditional practices despite reduced availability of plants in the wild after reservoir impoundment.

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Appendix

See Table 6.

Table 6 Plant species and uses

S. No	Species name	Family	Vernacular name	GF	Use(s)									
					MD	WE	TM	FD	FE	AI	RG	FP	FY	RF
1.	*Acacia catechu* (L.f.) Willd.	Leguminosae	Khayar	T	X									
2.	*Acacia pennata* (L.) Willd.	Leguminosae	Arphu lahara	C										
3.	*Achyranthes aspera* L.	Amaranthaceae	Datiwan	H										
4.	*Acorus calamus* L.	Araceae	Bojho	H	X						X			
5.	*Adiantum capillus-veneris* L	Pteridaceae	Pakhaale Uniu	P										
6.	*Adiantum caudatum* L.	Pteridaceae	Uniu	P										
7.	*Adiantum edgeworthii* Hook.	Pteridaceae	Uniu	P										
8.	*Adiantum philippense* L.	Pteridaceae	Kaane Uniu	P										
9.	*Adina cordifolia* (Roxb.) Benth. & Hook. f. ex B.D. Jacks.	Rubiaceae	Karma	T			X							
10.	*Aegle marmelos* (L.) Correa	Rutaceae	Bel	T	X	X								
11.	*Agave americana* L.*	Agavaceae		H										
12.	*Ageratum conyzoides* L.*	Compositae	Gandhe	H	X									
13.	*Albizia chinensis* (Osbeck) Merr.	Leguminosae	Seto siris	T			X							
14.	*Albizia lebbeck* (L.) Bentham	Leguminosae	Kalo siris	T			X							
15.	*Albizia lucidior* (Steudel) I. Nielson ex H. Hara	Leguminosae	Padke	T			X							
16.	*Alstonia scholaris* (L.) R. Br.	Apocynaceae	Chhatiwan	T	X									
17.	*Amaranthus spinosus* L.*	Amaranthaceae	Lude kanda	H										
18.	*Ananas comosus* (L.) Merr.*	Bromeliaceae	Bhui katahar	H					X					
19.	*Ardisia solanacea* Roxb.	Myrsinaceae	Seti kath	T										
20.	*Arisaema speciosum* (Wall.) Mart. ex Schott	Araceae	Sarpako makai	H										
21.	*Arisaema tortuosum* (Wall.) Schott	Araceae	Sarpako makai	H										
22.	*Artemisia indica* Willd.	Compositae	Pati	H	X						X			
23.	*Arundinella nepalensis* Trin.	Gramineae	Nigalo	H										

Table 6 continued

S. No	Species name	Family	Vernacular name	GF	Use(s)									
					MD	WE	TM	FD	FE	AI	RG	FP	FY	RF
24.	*Asparagus racemosus* Willd.	Liliaceae	Kurilo	H	X	X								
25.	*Artocarpus lakoocha* Wall. Ex Roxb.	Moraceae	Badahar	T	X									
26.	*Artocarpus integra* Merr.	Moraceae	Rukh katahar	T					X					
27.	*Azadirachta indica* A. Juss.*	Meliaceae	Neem	T	X									
28.	*Bambusa nepalensis* Stapleton	Gramineae	Choya bans	H		X								
29.	*Bauhinia purpurea* L.	Leguminosae	Tanki	T										
30.	*Bauhinia vahlii* Wight & Arn.	Leguminosae	Bhorla	L		X		X					X	
31.	*Bauhinia variegata* L.	Leguminosae	Koiralo	T	X	X								
32.	*Begonia tribenensis* C.R. Rao.	Begoniaceae	Makarkache	H	X									
33.	*Bidens pilosa* L.*	Compositae	Kuro	H										
34.	*Boehmeria rugulosa* Wedd.	Urticaceae	Dar, Githa	T	X									
35.	*Bombax ceiba* L.	Bombacaceae	Simal	T										
36.	*Brassaiopsis hainla* (Buch.-Ham. ex D. Don) Seem.	Araliaceae	Chunetro	T										
37.	*Butea minor* Buch.-Ham. ex Wall.	Leguminosae	Bhujetro	T										
38.	*Caesalpinia decapetala* (Roth.) Alston	Leguminosae	Arilae kanda	H										
39.	*Calotropis gigantea* (L.) W. T. Aiton	Asclepiadaceae	Aank	S	X									
40.	*Callicarpa arborea* Roxb.	Verbenaceae	Guyela	T										
41.	*Callicarpa macrophylla* Vahl.	Verbenaceae		S										
42.	*Cannabis sativa* L.*	Cannabaceae	Ganja	H	X									
43.	*Capillipedium assimile* (Steud.) A. Camus.	Gramineae	Muse Khari	H										
44.	*Cassia tora* L.*	Leguminosae	Chinchine	H										
45.	*Castanopsis indica* (Roxb. ex Lindl.) A. DC.	Fagaceae	Katus	T		X	X				X			
46.	*Celtis australis* L.	Ulmaceae	Khari	T										
47.	*Centella asiatica* (L.) Urban	Umbelliferae	Ghodtapre	H	X									

Table 6 continued

S. No	Species name	Family	Vernacular name	GF	Use(s)									
					MD	WE	TM	FD	FE	AI	RG	FP	FY	RF
48.	*Cheilanthes albomarginata* C.B. Clarke	Pteridaceae	Ranisinka	P										
49.	*Cheilanthes dalhosiae* Hooker	Pteridaceae	Ranisinka	P	X									
50.	*Cheilanthes tenuifolia* (Burm. fil.) Swarz	Pteridaceae	Ranisinka	P										
51.	*Chonemorpha fragrans* (Moon) Alston	Apocynaceae		C										
52.	*Chrysopogon aciculatus* (Retz.) Trin.	Gramineae	Kuro	H										
53.	*Cissampelos pareira* L.	Menispermaceae	Batulpate	C	X									
54.	*Cleome viscosa* L.	Capparaceae	Ban tori	H		X								
55.	*Clerodendrum chinense* (Osbeck) Mabberly	Verbenaceae		S										
56.	*Clerodendrum indicum* (L.) Kuntze.	Verbenaceae	Bhargi	S	X				X					
57.	*Clerodendrum japonicum* (Thunb.) Sweet	Verbenaceae		S										
58.	*Coccinia grandis* (L.) Voigt.	Cucurbitaceae	Goal kankri	C		X								
59.	*Coelogyne flaccida* Lindl.	Orchidaceae		E										
60.	*Colebrookea oppositifolia* Sm.	Labiatae	Dhurseli	S										
61.	*Costus speciosus* (J. Konig) Sm.	Zingiberaceae	Bet lauri	H										
62.	*Crateva unilocularis* Buch.-Ham.	Capparaceae	Sipligan	T		X								
63.	*Crotalaria alata* Buch.-Ham. ex D. Don	Leguminosae		H										
64.	*Cucurbita pepo* L.	Cucurbitaceae	Kubhindo	C									X	
65.	*Cuphea procumbens* Ortega.*	Lythraceae		H										
66.	*Curculigo orchioides* Gaertn.	Hypoxidaceae	Kalomusali	H										
67.	*Cuscuta reflexa* Roxb.	Convolvulaceae	Akasbeli	C	X									
68.	*Cyanotis cristata* (L.) D. Don	Commelinaceae		H										
69.	*Cynoglossum zeylanicum* (Vahl ex Hornem.) Thunb. ex Lehm.*	Boraginaceae	Kuro	H										
70.	*Cyperus rotundus* L.	Cyperaceae	Mothe	H										

Table 6 continued

S. No	Species name	Family	Vernacular name	GF	Use(s)									
					MD	WE	TM	FD	FE	AI	RG	FP	FY	RF
71.	*Dalbergia sissoo* Roxb. Ex DC.	Leguminosae	Sisoo	T			X							
72.	*Datura stramonium* L.*	Solanaceae	Dhaturo	H										
73.	*Daturo metel* L.*	Solanaceae	Dhaturo	S										
74.	*Dendrobium formosum* Roxb. ex Lindl.	Orchidaceae		E										
75.	*Dendrocalamus strictus* (Roxb.) Nees	Gramineae	Bans	H										
76.	*Desmodium confertum* DC	Leguminosae		S										
77.	*Desmodium gangeticum* (L.) DC	Leguminosae		S										
78.	*Desmodium laxiflorum* DC	Leguminosae		H										
79.	*Desmodium oojeinense* (Roxb.) H. Ohashi	Leguminosae	Sadan	T			X	X		X				
80.	*Desmostachys bipinnata* (L.) Stapf.	Gramineae	Kush	H							X			
81.	*Dioscorea bulbifera* L.	Dioscoreaceae	Githa	C		X								
82.	*Dioscorea deltoidea* Wall. ex Griseb	Dioscoreaceae	Tarul	C		X								
83.	*Diospyros malabarica* (Desr.) Kostel.	Ebenaceae	Tendu	T										
84.	*Drepanostachyum falcatum* (Nees) Keng f.	Gramineae	Phurke ghans	H										
85.	*Drepanostachyum intermedium* (Munro) Keng. f.	Gramineae	Nigalo	H										
86.	*Drymaria diandra* Blume	Caryophyllaceae	Abijalo	H	X									
87.	*Dryopteris cochleat* (D. Don) C. Chr.	Aspidiaceae	Niuro	P										
88.	*Dryopteris filix-mas* (L.) Schott.	Aspidiaceae	Unyu	P										
89.	*Duabanga grandiflora* (Roxb. ex. DC.) Walp	Lythraceae	Odal	T									X	
90.	*Elephantopus scaber* L.	Compositae	Sahasrajari	H	X									
91.	*Engelhardia spicata* Lesch. ex Blume	Juglandaceae	Mauwa	T			X							
92.	*Ensete glaucum* (Roxb.) Cheesman	Moraceae	Ban Kera	H	X	X								
93.	*Eragrostis tenella* (L.) P. Beauv. ex Roem. & Schult.	Gramineae		H										
94.	*Equisetum diffusum* D.Don.	Equisetaceae	Ankhle	P										

Table 6 continued

S. No	Species name	Family	Vernacular name	GF	Use(s)									
					MD	WE	TM	FD	FE	AI	RG	FP	FY	RF
95.	*Erythrina stricta* Roxb.	Leguminosae	Phaleto	T	X									
96.	*Eulaliopsis binata* (Retz.) C.E. Hubbard	Gramineae	Babiyo	H	X								X	X
97.	*Eupatorium adenophorum* Spreng.*	Compositae	Banmasa	H	X									
98.	*Euphorbia hirta* L.	Euphorbiaceae	Dudhe jhar	H	X									
99.	*Euphorbia pulcherrima* Wild. ex Klotzsch.	Euphorbiaceae	Lalupate	T										
100	*Euphorbia royleana* Boiss	Euphorbiaceae	Siudi	H										X
101	*Ficus benghalensis* L.	Moraceae	Bar	T										
102	*Ficus benjamina* L.	Moraceae	Sami	T										
103	*Ficus racemosa* L.	Moraceae	Dumbre	T		X		X						
104	*Ficus religiosa* L.	Moraceae	Pipal	T										
105	*Ficus sarmentosa* Buch.-Ham. ex Sm.	Moraceae	Bedulo	T		X		X						
106	*Ficus semicordata* Buch.-Ham ex Sm.	Moraceae	Khaniyo	T	X	X		X						
107	*Garuga pinnata* Roxb.	Burseraceae	Dabdabe	T				X						
108	*Globba racemosa* Sm.	Zingiberaceae		H										
109	*Habenaria commelinifolia* (Roxb.) Wall. ex Lindl.	Orchidaceae		H										
110	*Hedera nepalensis* K. Koch	Araliaceae		C										
111	*Hedychium ellipticum* Buch.-Ham.ex Sm.	Zingiberaceae		H										
112	*Holarrhena pubescens* Wall. ex G. Don	Apocynaceae	Ban khirro	T						X				
113	*Hydrocotyle nepalensis* Hook.	Umbelliferae		H										
114	*Ichnocarpus frutescens* (L.) W. T. Aiton	Apocynaceae		L										
115	*Imperata cylindrica* (L.) Raeusch.	Gramineae	Siru	H										
116	*Jasminum caudatum* Wall. ex Lindl.	Oleaceae	Jasmine	S										
117	*Jatropha curcas* L.*	Euphorbiaceae	Sajiwan	S	X									X
118	*Justicia adhatoda* L.	Acanthaceae	Asuro	S										

Table 6 continued

S. No	Species name	Family	Vernacular name	GF	Use(s)									
					MD	WE	TM	FD	FE	AI	RG	FP	FY	RF
119	*Lagerstroemia indica* L.	Lythraceae	Asarae	T										
120	*Lagerstroemia parviflora* Roxb.	Lythraceae	Botdhaero	T										
121	*Lantana camara* L.*	Verbenaceae	Banmara	H										
122	*Leea macrophylla* Roxb. ex Hornem.	Leeaceae	Galeni	S										
123	*Leucas cephalotes* (Roth) Spreng	Labiatae	Dronapuspi	H										
124	*Leucas lanata* Benth.	Labiatae		H										
125	*Leucosceptrum canum* Sm.	Labiatae		S										
126	*Ligustrum confusum* Decne.	Oleaceae		T										
127	*Litsea monopetala* (Roxb.) Pers.	Lauraceae	Kutmero	T										
128	*Lygodium flexuosum* (L.) Sw.	Schizaeaceae		P										
129	*Lygodium japonicum* (Thunb.) Sw.	Schizaeaceae		P										
130	*Macaranga denticulata* (Blume) Mull. Agr.	Euphorbiaceae		T										
131	*Maesa chisia* Buch.-Ham. ex D.Don	Myrsinaceae	Bilauni	T										
132	*Maesa macrophylla* (Wall.) A. DC.	Myrsinaceae	Bhogate	T								X		
133	*Mallotus philippensis* (Lam.) Mull.-Arg.	Euphorbiaceae	Sindure	T	X		X							
134	*Mangifera indica* L.*	Anacardiaceae	Aamp	T	X		X							
135	*Melastoma malabathricum* L.	Melastomataceae		S										
136	*Melia azederach* L.	Meliaceae	Bakaino	T										
137	*Melothria heterophylla* (Lour.) Cogn.	Cucurbitaceae		C										
138	*Michelia champaca* L.	Magnoliaceae	Champ	T	X									
139	*Mimosa pudica* L.*	Leguminosae	Lakkawati jhar	H	X									
140	*Momordica dioica* Roxb. ex Willd.	Cucurbitaceae	Ban Karela	C		X								
141	*Morus nigra* L.	Moraceae	Kimbu kafal	T	X	X								
142	*Murraya koenigii* (L.) Spreng.	Rutaceae		S										

Table 6 continued

S. No	Species name	Family	Vernacular name	GF	Use(s)									
					MD	WE	TM	FD	FE	AI	RG	FP	FY	RF
143	*Mussaenda macrophylla* Wall.	Rubiaceae	Dhobini	S	X									
144	*Myrica esculenta* Buch.-Ham. ex D.Don	Myricaceae	Kafal	T	X	X								
145	*Nephrolepis cordifolia* (L.) C. Presl	Davalliaceae	Pani Amala	P		X								
146	*Nicandra physalodes* (L.) Gaertn.	Solanaceae		H										
147	*Nyctanthes arbor-tristis* L.*	Oleaceae	Parijat	T										
148	*Oroxylum indicum* (L.) Kurz.	Bignoniaceae	Tatelo	T										
149	*Osbeckia chinensis* L.	Melastomataceae		S										
150	*Oxalis corniculata* L.	Oxalidaceae	Chariamilo	H	X									
151	*Pandanus nepalensis* St. John	Pandanaceae		S										
152	*Parthenium hysterophorus* L.*	Compositae		H										
153	*Pennisetum purpureum* Schum & Thom.*	Gramineae	Nepiar ghans	H										
154	*Phyllanthus amarus* Schum. & Thonn.	Euphorbiaceae		H										
155	*Phyllanthus emblica* L.	Euphorbiaceae	Amala	T	X	X								
156	*Physalis divaricata* D. Don	Solanaceae		H										
157	*Physalis peruviana* L.	Solanaceae		H										
158	*Pilea glaberrima* (Blume.) Blume.	Urticaceae		H										
159	*Piper longum* L.	Piperaceae	Pipla	C	X				X					
160	*Plumeria rubra* L.*	Apocynaceae	Golaichi	T										
161	*Premna barbata* Wall. ex Schauer	Verbenaceae	Ginari	T	X			X						
162	*Pterospermum lanceifolium* Roxb.	Sterculiaceae	Singane	T			X							
163	*Pyracantha crenulata* (D. Don) M. Roem.	Rosaceae		S										
164	*Quamoclit pennata* (Desr.) Bojer*	Convolvulaceae		C										
165	*Quisqualis indica* L.	Combretaceae		L										
166	*Rauvolfia serpentina* (L.) Benth ex. Kurz	Apocynaceae	Sarpagandha	H										

Table 6 continued

S. No	Species name	Family	Vernacular name	GF	Use(s)									
					MD	WE	TM	FD	FE	AI	RG	FP	FY	RF
167	*Remusatia pumila* (D. Don) Heng. Li & A. Hay	Araceae	Jaluko	H										
168	*Remusatia vivipara* (Roxb.) Schott.	Araceae	Jaluko	H		X								
169	*Rhus javanica* L.	Anacardiaceae	Bhakimlo	T		X								
170	*Ricinus communis* L.*	Euphorbiaceae	Ander	S										
171	*Rubus ellipticus* Sm.	Rosaceae	Aiselu	S	X	X								
172	*Saccharum officinarum* L.*	Gramineae	Ukhu	H					X					
173	*Saccharum spontaneum* L.	Gramineae	Kans	H	X									
174	*Salvia plebeia* R.Br.	Labiatae		H										
175	*Salvia coccinea* Buc'hoz ex Etl.	Labiatae		H										
176	*Selaginella pallida* (Hook. et. Grev.) Spring	Selaginellaceae		P										
177	*Sapindus mukorossi* Gaertn.*	Sapindaceae	Ritha	T										
178	*Sapium baccatum* Roxb.	Euphorbiaceae	Ban pipal	T			X							
179	*Sapium insigne* (Royle) Benth. & Hook.f.	Euphorbiaceae	Khirro	T			X					X		
180	*Sarcococca coriacea* (Hook.) Sweet	Buxaceae		S										
181	*Schima wallichii* (DC.) Korth	Theaceae	Chilaune	T			X			X		X		
182	*Scutellaria discolor* Colebr.	Labiatae		H										
183	*Shorea robusta* Gaertn.	Dipterocarpaceae	Sal	T	X		X	X		X				
184	*Sida rhombifolia* L.	Malvaceae		H										
185	*Sida cordata* (Burm.f.) Borss. Waalk.	Malvaceae		H										
186	*Sigesbeckia orientalis* L.	Compositae		S										
187	*Smilax ovalifolia* Roxb. ex D. Don.	Liliaceae	Kukurdaino	C		X								
188	*Smilax perfoliata* Lour	Liliaceae		C										
189	*Smilax wightii* A. DC.	Liliaceae		C										
190	*Solanum nigrum* L.	Solanaceae	Bihi	H										

Table 6 continued

S. No	Species name	Family	Vernacular name	GF	Use(s)									
					MD	WE	TM	FD	FE	AI	RG	FP	FY	RF
191	*Solanum torvum* Sw.	Solanaceae		H										
192	*Solanum surattense* Burm.f.	Solanaceae	Kantakari	H	X									
193	*Solena heterophylla* Lour.	Cucurbitaceae	Bankankri	C										
194	*Sonchus wightianus* DC.	Compositae	Mulapate	H					X					
195	*Sphenomeris chinensis* (L.) Maxon	Pteridaceae		P										
196	*Spondias pinnata* (L.f.) Kurz*	Anacardiaceae	Amaro	T	X	X								
197	*Stephania japonica* var *discolor* (Blume) Forman	Menispermaceae		L										
198	*Strobilanthes angustifrons* C.B. Clarke	Acanthaceae		H										
199	*Symplocos pyrifolia* Wall. ex G. Don.	Symplocaceae	Kali Kath	S			X			X				
200	*Syzygium cumini* (L.) Skeels	Myrtaceae	Jamun	T	X	X								
201	*Tamarindus indica* L.*	Leguminosae	Amili	T										
202	*Tectaria macrodonta* (Fee) C. Chr.	Dryopteridaceae	Kali neuro	P	X	X								
203	*Pteris vittata* L.	Pteridaceae	Unniu	P										
204	*Pteris wallichiana* J. Agardh.	Pteridaceae	Unniu	P										
205	*Terminalia alata* Heyne ex Roth	Combretaceae	Saj	T			X	X						
206	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae	Barro	T	X									
207	*Terminalia chebula* Retz.	Combretaceae	Harro	T	X									
208	*Tetrastigma serrulatum* (Roxb.) Planch.	Vitaceae		C										
209	*Themeda arundinacea* (Roxb.) A. Camus	Gramineae	Dhadi ghans	H										X
210	*Themeda triandra* Forssk	Gramineae	Khar	H										X
211	*Thespesia lampas* (Cav.) Dalzell & A. Gibson	Malvaceae	Ban kapas	H	X									
212	*Thysanolaena maxima* (Roxb.) Kuntze	Gramineae	Amriso	H										
213	*Tinospora cordifolia* (Willd.) Miers.	Menispermaceae	Gurjo	L	X									
214	*Trewia nudiflora* L.	Euphorbiaceae	Ramritha	T										

Table 6 continued

S. No	Species name	Family	Vernacular name	GF	Use(s)									
					MD	WE	TM	FD	FE	AI	RG	FP	FY	RF
215	*Urena lobata* L.	Malvaceae	Kuro	H										
216	*Urtica dioica* L.	Urticaceae	Sisnu	H		X								
217	*Vanda teres* Lindl.	Orchidaceae	Rukh kera	E	X									
218	*Viscum album* L.	Loranthaceae	Hadchur	S	X									
219	*Vitis lanata* Roxb.	Vitaceae		C										
220	*Woodfordia fruticosa* (L.) Kurz	Lythraceae	Dhayero	S	X									
221	*Zizyphus rugosa* Lam.	Rhamnaceae	Bayar	S	X	X								

GF Growth Form, *T* Tree, *S* Shrub, *H* Herb, *C* Climber, *L* Liana, *E* Epiphyte, *P* Pteridophytes, *MD* Medicinal Plant, *WE* Wild Edible, *TM* Timber, *FD* Fodder, *FE* Fermentation, *AI* Agricultural Implements, *RG* Religious, *FP* Fish Poisoning, *FY* Fiber Yielding, *RF* Roofing and Fencing

* Exotic species

All uses (columns) for each species are marked by an X

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