Our Nature (2011) 9: 146-155

Aquatic Plant Resources of Betana Wetland, Morang, Nepal

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Received: 24.05.2011, Accepted: 13.11.2011

Abstract
A total of 84 aquatic plant species belonging to 71 genera and 41 families were recorded during January 2008 to December 2009 from Betana pond. They were classified into 7 growth forms as helophytes (22), tenagophytes (24), hyperhydates (23), epihydates (2), rosulates (3), vittates (6), and pleustophytes (4). Socio-economically useful plants included: medicinal (28 sp), wild food (19 sp), feed/fodder (28 sp), handicrafts (6 sp), and thatching (5 sp).

***Key words*:** Availability, growth form, ox-bow pond, socio-economy.

Introduction

Wetlands are valuable sources, sinks, and transformers of chemical, biological and genetic materials. They are one of the most productive ecosystems in the world and essential life supporting systems providing a wide array of benefits (Mitsch and Gooselink, 2000). Abundance of aquatic plants is valuable characteristics of a wetland and constitutes a prominent component of aquatic ecosystems. They dynamically guide the cycling of minerals and other organic constituents, thereby influencing overall biomass production of water bodies and can serve as indicator for monitoring the degree of damage in the ecosystem. Aquatic plants serve as wild food, fodder, medicine, handicrafts, thatching, compost, breeding genetic stock etc. freely to mankind and play significant role in socio-economy and culture.

Betana wetland is rich in biodiversity (Jha *et al.,* 2005; Subba and Thapa, 2005; Niroula and Singh, 2010; Niroula *et al*., 2010). It supports about 4000 households of surrounding villages for irrigation, livestock grazing, wild food, fodder and fuel collection, thatch/reed harvesting, fishing and recreation. Overexploitation threats the beauty and continuous supply of resources including aquatic plants. There is urgent need to investigate the aquatic plant resources and potential values for their sustainable management. Present paper highlights the aquatic plant resources with their potential uses, availability, growth forms and flowering phenology.

Materials and methods

Betana (lat 26°39'N, long 87°25'E, alt. 115 m msl) spread in 5.5 ha at the fringe of the Char-Koshe–Jhadi is a natural freshwater ox-bow pond. It lies in the Belbari VDC, Morang, 26 km north east away from Biratnagar township. The pond is fed by

direct atmospheric precipitation and water released by the forest vegetation surrounding the pond. The water is drained out through outlets constructed at the southern bank particularly during rainy season when the pond becomes completely filled with water. East, west and north sides of the pond are surrounded by Sal forest (Char-Koshe-Jhadi) and the south side is lined by East-West Mahendra Highway.

The study site has alluvial soil and tropical monsoonic climate accompanied three distinct seasons *viz.,* winter (November-February), summer (March-June) and rainy (July-October) in a year. The average annual rainfall is 1312 mm, average annual minimum and maximum temperatures 14.2°C and 30.6°C, respectively.

The specimens of the aquatic plants were collected manually at monthly intervals from January 2008 to December 2009. The specimens were tagged and pressed to prepare herbaria. Identification was done with the help of standard literature (Hooker, 1872-1897; Cook, 1996; Gupta, 2001). The identified specimens were confirmed by making cross checks with the specimens at the Plant Systematics, Research Centre, University Department of Botany, T.M. Bhagalpur University, Bhagalpur, India. The specimens have been deposited in TU Herbarium, Department of Botany, Post Graduate Campus, T.U., Biratnagar, Nepal. Uses of the plants were determined either through interviews with local people or with the help of literature (Shrestha, 1996; Dangol, 2000-2001; GON, 2007; Mukherjee and Bala, 2007). The nomenclature of plants is based on Hara *et al*. (1978-1982); Press *et al*. (2000) and growth form categories of aquatic plants were determined as per Cook (1996).

Results and discussion

A total of 84 aquatic plants (Bryophyta-1, Pteridophyta-6, and Angiosperms-78) belonging to 71 genera and 41 families were recorded. The dominance of monocots (42 sp) over dicots (35 sp) by species count but reverse case by number of families (Dicots-21, Monocots-14) approached the study of Shrestha (1996), and Niroula and Singh (2010). They were classified into following growth forms depending upon nature and type of habitat and their contact with soil, water and air (Tab. 1).

(1) Helophytes: plants were not physiologically bound to water but tolerated longer period of submergence (22 sp). (2) Tenagophytes: juvenile phase of the plants were either submerged or floating on water but the flowering phase were terrestrial (24 sp). (3) Hyperhydates: roots penetrated the substrate; their leaves/stems emerged above the water surface (23 sp). (4) Epihydates: roots penetrated the substrate, their leaves/stems floating on but not arose above water surface (2 sp). (5) Rosulates: plants rooted in the substrate with all photosynthetic parts submerged and leaves borne in rosette (3 sp). (6) Vittates: plants rooted in the substrate with all photosynthetic parts submerged and leaves arranged along elongated stems (6 sp). (7) Pleustophytes: some photosynthetic parts in contact with air, free floating on the surface but not attached to the substrate (4 sp).

As many as 28 species were found to have medicinal uses against diseases of different types; 19 species were wild food (young shoots. fronds, rhizomes and fruits) as cooked vegetables; 28 species were feed/fodder of animals; 6 species were for handicrafts, and 5 species were utilized for thatching huts, village homes and fencing. Similarly, the number of aquatic plant

Table 1. List of aquatic plants occurring in Betana wetland.

SN	Group/family/species	Local name	Growth form	Fl. colour	Flowering fruiting	Uses	Availability
	BRYOPHYTA						
	Ricciaceae						
1	*Riccia fluitans* L.	Leu	pleustophyte	-		-	scarce
	PTERIDOPHYTA						
	Athyriaceae						
2	*Dipazium esculentum* (Retz.) Sw	Niguro	helophyte	-		fronds vegetable.	frequent
	Azollaceae						
3	*Azolla imbricata* (Roxb.) Nakai	Pani uneu	pleustophyte	-		forage for cattle, poultry feed, green manure, compost.	common
	Equisetaceae						
4	*Equisetum debile* Roxb. ex Vaucher	Kurkure	helophyte	-		malaria fever.	frequent
	Parkeriaceae						
5	*Ceratopteris thalictroides* Brongn	Panidhaniya	tenagophytes	-		vegetabe, compost.	common
	Thelypteridaceae						
6	*Meniscium proliferum* (Retz.) Sw	Uneu	helophyte	-		-	frequent
7	*Thelypteris dentata* (Forsk.) St. John	Uneu	helophyte	-		-	common
	ANGIOSPERMAE-DICOTS						
	Acanthaceae						
8	*Hygrophila difformis* (L. f.) Blume	Talmakhan	hyperhydate	purple	Sep-Dec	-	frequent
9	*H. polysperma* (Roxb.) T. Anders	Talmakhan	hyperhydate	purple	Sep-Dec	-	frequent
10	*H. quadrivalvis* (Ham.) Nees	Talmakhan	hyperhydate	purple	Sep-Dec	-	frequent
	Amaranthaceae						
11	*Alternanthera sessilis* (L.) DC	Bhringijhar	helophyte	white	Apr-Sep	galactogogue,cholagogue, febrifuge, indigestion, vegetable.	common
	Apiaceae						
12	*Centella asiatica* (L.) Urb.	Ghodtapre	helophyte	purple	all seasons	alterative, tonic, diuretic, decoction in leprosy, diseases of nervous system and heart, insecticide, vegetable condiments.	frequent
13	*Oenanthe javanica* (Blume) DC	-	hyperhydate	white	May-Jul		common

Contd....

Table 1-Contd....

	Asclepiadaceae						
14	*Oxystelma esculentum* (L.f) Sm. Hara	Barasinge	helophyte	purple	Sep-Nov	diuretic, laxative, aphrodisiac, anthelmintic, leucoderma, bronchitis, decoction as a gargle in aphthosse ulceration of mouth and sore throat tonic, seed expectorent.	frequent
	Asteraceae						
15	*Adenostemma lavenia* var. *latifolium* (D. Don.) Panigrahi	-	tenagophyte	white	Oct-Dec	-	frequent
16	*Eclipta prostrata* (L.) L.	Bhringaraj	helophyte	white	all seasons	hair vitalizer, catarrhal jaundice, tonic, deobstruent, in common hepatic and spleen enlargements, skin diseases, blue dye, vegetable.	common
17	*Enydra fluctuans* Lourerio	Sungurejhar	vittate	cream	Mar-Jun	skin diseases, nervous disorders, fodder, pig feed.	common
18	*Mikania micrantha* Kunth	Banmara	helophyte	cream	Nov-Mar	invasive allien weed.	common
19	*Spilanthes iabadicensis* A. H. Moore	Purpure	tenagophyte	yellow	all seasons	stimulant, sialogogue, toothache, headche, expels intestinal worms in calves and lambs.	frequent
	Brassicaceae						
20	*Rorippa nasturtium-aquaticum* (L.)Hayek.	Simesag	hyperhydate	white	Dec-Jul	antiscrobutic and stimulant, eaten fresh to improve appetite, vegetatabe.	frequent
	Callitrichaceae						
21	*Callitriche stagnalis* Scopoli	-	vittate	white	Oct-Dec	-	scarce
	Cabombaceae						
22	*Caboma aquatica* Aublet	Panijhar	vittate	white	Oct-Dec	ornamental aquarium plant, fodder.	frequent
	Ceratophyllaceae						
23	*Ceratophyllum demersum* L.	Patai	vittate	white	Oct-Nov	antipyretic,scorpion sting and biliousness, hyper accumulator of havy metals, ornamental aquarium plant	common
	Convolvulaceae						
24	*Ipomoea aquatica* Forssk.	Karmisag	epihydate	pink	Mar-Dec	emetic, purgative and antidote to opium and arsenic poisoning, vegetable.	frequent
25	*I. carnea* Jacq. subsp. *fistulosa* (Mart. ex	Thetar	hyperhydate	pink	Apr-Jan	insecticidal, hedge plant of crop field,	common

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Table 1-Contd....

	choisy) D.F. Austin					fire wood, flood controller, invasive allien weed.	
	Fabaceae						
26	*Smithia ciliata* Royle	-	tenagophyte	yellow	Sep-Nov	fodder.	frequent
	Hydrophyllaceae						
27	*Hydrolea zeylanica* (L.) Vahl	Niljal	hyperhydate	blue	NovFeb	leaves poultice for callus ulcers.	common
	Lamiaceae						
28	*Dysophylla cruciata* Benth.	-	tenagophyte	purple	Dec-Feb	-	frequent
	Lythraceae						
29	*Rotala rotundifolia* (Buch.-Ham.) Koehne	-	tenagophyte	pink	Apr-Aug	-	scarce
	Melastomaceae						
30	*Osbekia stellata* (Buch.-Ham. ex Roxb.) Koehne	Angeri	helophyte	white	Aug-Jan	fruits raw food.	common
	Onagraceae						
31	*Ludwigia octovalvis* (Jacq.) Raven	Luwange	hyperhydate	yellow	Oct-Jan	astringent, carminative,vermifuge, laxative, diuretic, anti-inflammatory, expectorent and febrifuge.	frequent
32	*L. perennis* L.	Luwange	tenagophyte	yellow	Sep-Jan	febrifuge.	common
	Polygonaceae						
33	*Polygonum hydropiper* L.	Pirrejhar	tenagophyte	red	Jul-Dec	uterine disorders, oral contraceptive, fish poison, yellow dye.	common
34	*P. lapathifolium* L.	Pirrejhar	hyperhydate	pink	Aug-Nov	fish poison	common
35	*P. plebeium* R. Br.	-	helophyte	red	Jan-Jul	bowel disorders. pneumonia.	frequent
	Ranunculaceae						
36	*Ranunculus scleratus* L.	Panidhaniya	hyperhydate	yellow	Jan-Apr	rheumatism. dysuria, asthma, pneumonia, seeds in kidney troubles.	scarce
	Scrophulariaceae						
37	*Limnophila heterophylla* (Roxb.) Benth.	-	vittate	cream	all seasons	-	common
38	*L. indica* (L.) Druce		hyperhydate	purple	Oct-Dec	antiseptic, elephantiasis, pestilent fever, dysentery, vegetable.	scarce
39	*Lindernia ciliata* (Colsm.) Pennell	-	helophyte	pink	Jul-Dec	vegetable.	frequent
40	*L. crustacea* (L.) F. Muell	-	helophyte	pink	Jan-Apr	-	frequent
	Sphenocleaceae						

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Table 1-Contd....

41	*Sphenoclea zeylanica* Garrtn.	Bahunisag	tenagophyte	cream	Jul-Nov	vegetable.	frequent
	Verbenaceae						
42	*Lippia nodiflora* (L.) Rich.	-	helophyte	purple	Apr-Dec	cooling, diuretic, febrifuge, headache, indigestion, vegetable.	frequent
	ANGIOSPERMAE-MONOCOTS						
	Alismataceae						
43	*Sagittaria guyanensis* Kunth	-	epihydate	white	Sep-Nov	rhizome vegetable.	scarce
44	*S. trifolia* L.	Laph	tenagophyte	white	Jan-Jul	rhizome vegetable.	frequent
	Aponogetonaceae						
45	*Aponogeton appendiculatus* H. Bruggen	-	rosulate	cream	Aug-Jan	-	frequent
	Araceae						
46	*Acorus calamus* L.	Bojho	tenagophyte	brown	Apr-Jan	anti-inflammatory, sudorific, antiseptic, dyspepsia, calculi, dry powderded rhizome-grain storage.	frequent
47	*Colocasia esculenta* (L.) Shoot.	Karkalo	tenagophyte	cream	Jul-Oct	leaf juice styptic, stimulant and rubifacient, corm laxative and anodyne.	frequent
48	*Lasia spinosa* L.	Morange	tenagophyte	purple	Apr-Aug	vegetable.	common
49	*Pistia stratiotes* L.	Panibanda	pleustophyte	pink	Oct-Dec	juice in earache, ashes applied to ringworm infection, leaves in eczema, leprosy, ulcer.	common
	Arecaceae						
50	*Calamus tenuis* Roxb.	Bet	helophyte	yellow	Jul-Dec	furniture and handicrafts.	Scarce
	Cannaceae						
51	*Canna indica* L.	Phultarul	tenagophyte	red/yellow	all seasons	rhizome animal feed, fodder of wild boar.	Scarce
	Commelinaceae						
52	*Commelina benghalensis* L.	Kane	helophyte	blue	Jul-Nov	leprosy, emollient, demulcent, refrigerant, laxative.	common
53	*Floscopa scandens* L.	Kane	tenagophyyte	pink	Jul-Nov	stem juice put into eye sore, fodder.	common
	Cyperaceae						
54	*Carex nubigena* D. Don	Hatkatuwa	hyperhydate	green	Mar-Dec	fodder.	common
55	*Cyperus compressus* L.	Mothe	helophyte	green	Jun-Dec	fodder.	frequent
56	*C. corymbosus* Rottb.	Gudmothe	tenagophyte	green	Jun-Nov	mats, handicrafts.	frequent

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Table 1-Contd....

57	*C. nutans* Vahl.	Mothe	tenagophyte	brown	Aug-Nov	fodder.	frequent
58	*Fimbristylis dichotoma* (L.) Vahl	Mothe	hyperhydate	brown	Aug-Dec	fodder.	common
59	*Mariscus compactus* (Retz.) Druce	Mothe	tenagophyte	brown	Aug-Dec	-	common
60	*Pycreus flavidus* (Retz.) Koyama	Mothe	tenagophyte	brown	Aug-Nov	-	frequent
61	*Schoenoplectus mucronatus* (L.) Palla	Mothe	hyperhydate	brown	all seasons	mats, handicrafts.	common
	Eriocaulaceae						
62	*Eriocaulon trilobum* Ham. Kornicke	-	hyperhydate	white	Jul-Nov	-	common
	Hydrocharitaceae						
63	*Blyxa japonica* (Miq.) Maxim. ex Aschers. & Gurke	Sungurejhar	vittate	cream	Sep-Nov	pig feed, compost, mulch.	abundant
64	*Hydrocharis morsus-ranae* L.	Phulkekamal	rosulate	white	Sep-Dec	-	scarce
65	*Ottelia alismoides* (L.) Pers.	Hilejhar	rosulate	white	Aug-Dec	rubifacient, leaves and fruits vegetable.	frequent
	Juncaceae						
66	*Juncus bufonious* L.	Mothe	hyperhydate	green	Jul-Nov	fodder.	frequent
	Pandanaceae						
67	*Pandanus nepalensis* St. John	Dandikath	helophyte	pink	Jul-Nov	smallpox, syphilis, scabies and leucoderma, oil extraction stimulant, antiseptic, headache and rheumatism, religious.	frequent
	Poaceae						
68	*Arundinella benghalensis* (Sprengel) Druce	Panigans	hyperhydate	green	Aug-Nov	fodder.	frequent
69	*Cynodon dactylon* (L.) Pers.	Dobo	helophyte	green	Jul-Nov	astringent, hysteria, epilepsy, insanity, chronic diarrhoea, dysentery and opthalmic catarrh, diuretic, haemostatic, religious, fodder.	common
70	*Hemarthria compressa* (L. f.) R. Br.	Ghodedubo	tenagophyte	green	Jan-Nov	fodder.	frequent
71	*Hymenachne pseudointerrupta* C. Mueller	Panighans	hyperhydate	green	Sep-Jan	fodder.	frequent
72	*Eragrostis unioloides* (Retz.) Nees ex Steudel	-	helophyte	green	Aug-Dec	fodder.	frequent
73	*Isachne dispar* Trin.	-	tenagophyte	purple	Sep-Dec	fodder.	frequent
74	*Leersia hexandra* Swartz.	Karaute	hyperhydate	brown	all seasons	fodder, breeding genetic stock of rice.	frequent
75	*Panicum paludosum* Roxb.	Janaighans	hyperhydate	green	Aug-Nov	fodder	frequent

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Table 1-Contd....

76	*P. psiliopodium* Trin.	Janaighans	tenagophyte	brown	Jun-Oct	fodder.	frequent
77	*Paspalum scrobiculatum* L.	Banso	tenagophyte	green	Jul-Feb	astringent, cooling, constipating, diuretic, sedative, alexeteric, styptic and tonic, useful in ulcers, flatulence strangury and diarrhoea.	frequent
78	*Phragmites karka* (Retz.) Trin. ex Steudel	Narkat	helophyte	white	Jul-Dec	handicrafts, fodder, nesting habitats of birds, fodder.	common
79	*Saccharum spontaneum* L.	Kans	helophyte	white	Aug- Nov	laxative, aphrodisiac, burning sensation, strangury, pthisis, calculi, biliousness and certain diseases of blood, galactogogue and diuretic, thatching, pulp for paper boards, peduncles- handicrafts, silky florets-stuffing, breeding genetic stock of sugarcane, nesting habitats of water fowls.	common
80	*Vetiveria zizanioides* (L.) Nash	Khus-khus	tenagophyte	Brown	Jul-Dec	refrigerant, febrifuge, diaphoretic, stimulant, stomachic, emenagogue, thatching, handicrafts (carving household containers, coaster, casserole, ashtrays, table mattress, soap case, telephone box); broom, fodder.	scarce
	Pontederiaceae						
81	*Eichhornia crassipes* (Mart.) Solms	Jalkumbhi	pleustophytes	purple	Apr-Nov	hyper-accumulator of heavy metals, biogas generator, compost, mulch.	abundant
82	*Monochoria hastata* (L.) Solms	Niljalkumbhi	hyperhydate	blue	Jul-Oct	tonic, alterative, insanity, vegetable, fodder.	frequent
83	*Monochoria vaginalis* (Brum.) Kunth	Niljalkumbhi	hyperhydate	blue	Aug-Nov	roots toothache, asthma, stomach and liver complaints, cough, compost, mulch.	frequent
	Typhaceae						
84	*Typha angustifolia* L.	Pater	hyperhydate	brown	Jul-Nov	thatching, handicrafts, mats, silky florets of spike-stuffing, rhizome fodder of wild boar.	common

species potentially useful was: compost/manure (6), insecticide (3), breeding genetic stock (2), fish poison (2), ornamental aquarium (2), dyes (2), and hedge of crop field (1). Dried rhizome powder of *Acorus calamus* was utilized for grain storage against the attack of insects.

The plants were oxygenator, food, spawning/nesting habitats of aquatic animals, hyper accumulator of heavy metals etc; *Cynodon dactylon*, *Eclipta prostrata*, *Pandanus nepalensis* were used in ceremonies and festivals. *Centella asiatica, Cynodon dactylon*, *Eclipta prostrata*, *Ipomoea carnea*, *Phragmites karka*, *Saccharum spontaneum*, *Typha angustifolia* and *Vetiveria zizanioides* were multipurpose useful plants. *Calamus tenuis* was scarce due to overexploitation and a nationally threatened aquatic plant of Nepal - *Pandanus nepalensis* was frequent in the wetland. *Eichhornia crassipes*, *Ipomoea carnea*, *Mikania micrantha*, and *Pistia stratiotes* were invasive alien species (IAS). Availability of aquatic plants in the Betana wetland were: frequent (46%), common (37.6%), scarce (14.1%) and abundant (2.3%) on their percentage contribution. *Blyxa japonica* and *Eichhornia crassipes* were abundant species (Tab. 1).

Deforestation, livestock grazing, public pressure for recreation, overexploitation of aquatic plant resources and pollution were major challenges for the conservation of Betana wetland. Public awareness for sustainable use of wetland resources, ecological and biological research are inevitable for better management through the concept of ecotourism by local and government level.

Acknowledgements

We are grateful to Head, University Department of Botany, T.M. Bhagalpur University, Bhagalpur for library facility. The first author is thankful to Dr. S. Jha, Professor and Head, Department of Botany and Dr. B.R. Subba, Department of Zoology P.G. Campus T.U., Biratnagar, Nepal for encouragements. IOST, Dean, T.U., and U.G.C. Nepal are acknowledged for study leave and partial financial support.

References

Cook, C.D.K. 1996. *Aquatic and wetland plants of India*. Oxford University Press, Oxford-New York-Delhi.

Dangol, D.R. 2000-2001. Aquatic plant resources and their uses: observation from Beeshazar lake, Chitwan. *J. Inst. Agric. Anim. Sci.* ***21-22*****:** 119-133.

GON (Government of Nepal) 2007. *Medicinal plants of Nepal*. Ministry of Forests and Soil Conservation, Department of Plant Resources, Thapathali, Kathmandu, Nepal.

Gupta, O.P. 2001. *Weedy aquatic plants: their utility, menace and management.* Agrobios (India), Jodhpur.

Hara, H., A.O. Chater and L.H. Williams 1982. *An enumeration of the flowering plants of Nepal* Vol.3. British Museum (Nat. Hist.), London.

Hara, H., W.T. Stearn and L.H. Williams 1978. *An enumeration of the flowering plants of Nepal* Vol. 1.British Museum (Nat. Hist.), London.

Hooker, J.D. 1872-1897. *The flora of British India,* 7 volumes L. Reeve, London.

Jha, S., U. Koirala and B. Niroula 2005. *Plant resources of Betana Taal and adjoining areas.* Report submitted to Association for Protection of Environment and Culture (APEC), Biratnagar.

Mitsch, W.J. and J.G. Gosselink 2000. *Wetlands.* John Wiley and Sons, Inc. New York.

Mukherjee, A. and G. Bala 2007. Useful plants of

wetlands in Nadia district, west Bengal. *Geobios* ***34*****:** 253-256.

Niroula, B. and K.L.B. Singh 2010. Contribution to aquatic macrophytes of Biratnagar and adjoining areas, eastern Nepal. *Ecoprint* ***17*****:** 23-34.

Niroula, B., K.L.B. Singh, G. Thapa and J. Pal 2010. Seasonal variations in physico-chemical properties and biodiversity in Betana pond, eastern Nepal. *Our Nature* ***8*****:** 212-218.

Shrestha, P. 1996. Diversity of aquatic macrophytes in the Koshi Tappu Wildlife Reserve and surrounding areas, eastern Nepal. In: *Environment and biodiversity in the context of south Asia* (Eds. P.K. Jha, Ghimire G.P.S., Karmacharya, S.B. and P. Lacoul). Ecological Society (ECOS), Kathmandu. pp. 203-211.

Subba, B.R. and D.T. Chhetry 2005. *A report on the syudy of Betana wetland, Blelbari V.D.C., Morang district.* Report submitted to Association for Protection of Environment and Culture (APEC), Biratnagar.