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Research Article

ECOSYSTEM SERVICES AND STAKEHOLDER ANALYSIS IN BISHAJARI LAKE AND ASSOCIATED WETLAND AREAS, CHITWAN, NEPAL

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Abstract

Wetlands as other ecosystems deliver goods and services of enormous value to the human society and are regarded as one of the most productive ecosystems. We assessed the ecosystem services delivered by Bishajari Lake and its associated wetland areas of Chitwan district during June to August, 2012. A household survey consisting 110 households, interviews with key informants, group discussions and stakeholder analysis were carried out for this purpose to document the overall status of ecosystem services, evaluate the provisional services generated by the lakes, understand potentials for payment to ecosystem services, and identify stakeholders involved and their roles and responsibilities. A total of 12 fish species, 17 wild and domestic fruits, 12 timber species, 15 fodder species, 20 wild vegetables species and 31 medicinal plant species were recorded. Moreover 65.5% of respondents were found receiving some sort of income from the wetland area. The majority of respondents felt that the ecosystem is being changed mostly on provisional services. So far with little support from government, the local people have practiced some adaptive responses like biogas plant, afforestation, electric fencing, contract fisheries, ecotourism and other climate-smart measures. It suggest that raising awareness and sharing information among the locals should be done more frequently and effectively to continuously cope with ecosystem change.

Key words: Wetland; ecosystem services; stakeholders; awareness

Introduction

Bishajari Lake and associated wetlands area deliver goods and services of enormous value to the human society. Millennium Ecosystem Assessment carried out between 2001 and 2005 concluded that wetlands and the ecosystem services they provide are hugely valuable to people worldwide (MEA, 2005). Services provided by inland water are vital for poverty alleviation (Revenga and Kura,2003). Turner *et al*., 2008, found that over the last 30 years, a range of studies has provided estimates of the economic value of wetlands, demonstrating both the range of wetland benefits and the use and reliability of valuation methods.

Nepal being one of the rich countries in water resources and wetlands, ecosystem services and payment to ecosystem services can assist a great deal in uplifting the livelihood of people. This study assessed and listed the major ecosystem services on one of the important Ramsar sites of the country. Stakeholders' analysis, which can contribute to management of such pristine sites, is also on the focus of the study.

The broad objective of this study is to assess the ecosystem services from Bishajari Lake and associated wetland area and the study specifically aims to (a) identify the services provided by the wetlands in Chitwan context; (b) identify, analyse and document perceptions of different stakeholders at around the study area on the status of ecosystem services

Materials and Methods

Study area

The Bishajari Lake and Associated wetland area lies in Gitanagar and Bachauli VDCs, Bharatpur and Ratnanagar Municipilaties, 15 km from Narayanghat bazaar, Chitawan District, Narayani Zone, Nepal. The morphometry of the wetland is latitude of 27.614 º N to 27.621º N and longitude of 84.4383 º E to 84.4385 º E. (CGIAR/CIAT, 2013). The Ramsar site covers the area of 3200 hactres.

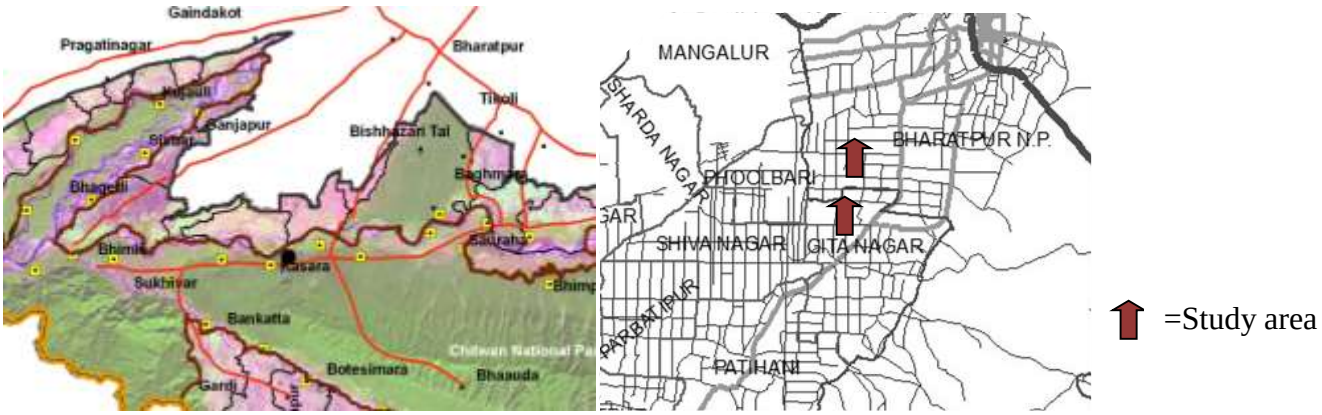

Fig. 1: Bishajari lake and associated area and the study site

Data collection

Participatory and exploratory research methods was used which included administration of questionnaires, key informant interviews, focus group discussion, field observations, and experts' consultations were used in the process. 110 respondents at around the wetland area were selected at random to include in the survey.Observations were made and information recorded at lake premises, community sources and landscapes around the wetland area by systematically walking with informants and local leaders through the villages while observing, asking, seeking problems and solutions.

A scoping exercise was performed in two steps to identify stakeholders. First, a brainstorming exercise was held with Bandevi Barandabhar Community Forest Users group members representing extensive ecosystem and ecosystem services knowledge along with some ethnobotanical knowledge.

Data analysis

The information-coded data was statistically analyzed using Statistical Package for Social Sciences (SPSS version 20). Both descriptive and analytical methods were used to analyze the data.

The valuation of ecosystem services was done based on the framework of the current use and it is less than actual or potential value.

Results and Discussion

General information of respondents

The age distribution of the respondents showed that 6 respondents (5.4 %) were less than 30 years, 46 respondents (41.8%) were of 30-40 years, 45 (40.9%) of 40-50 years, 11 (10%) of 50-60 years and 2 (1.8%) were more than 60 years. Among the interviewed respondents 39 respondents (35.5%) were female and 71 respondents (65.5%) were male. Around 97% people have 0.77 hectare land in average which is less than national average landholding size i.e. 0.79 hectare whereas 3% have only 0.038 hectare (1kattha) land.

Knowledge and experiences of ecosystem services

Based on the interview 12 different local and exotic species of fishes, 18 fruits, 13 timber species, 16 fodder species, 22 traditional vegetables and 31 medicinal plants useful for 12 different diseases were documented in the study area which is shown in the Table 1.

Moreover, 65.5% of respondents were found to receive some sort of income from wetland. Moreover, according to Dangol (2002) resources of Western Chitwan provide a number of medicinal plant resources used for combating different health problems of human and livestock. Plants as a whole or its parts in the form of juice, decoction, ash, or infusion are prescribed externally or internally.

The Table 2 shows the realized values of ecosystems services. Actual or potential value is substantially greater than this. The livelihoods of people living in, or on the borders of, wetland often depend partially or entirely on wetland ecosystem services but have not been practiced properly. In most of the cases, maximizing watershed services through payment systems has led to poverty reduction (Asquith et al. 2007).

The example of such valuation is practiced worldwide. For e.g. In Cambodia fish from the freshwater wetland ecosystem provides 60-80% of the country's animal protein. Also, in Malawi, local people use the fruits, seeds, tubers, roots and leaves of around 200 plants from the wetlands surrounding Lake Chilwa. In Malaysia, rural households earn up to US$80 a month selling medicinal plants gathered from wetlands. Globally, wetland peat deposits take up just 3% of the land area but store 14- 16% of the soil carbon pool (Tharme et al. 2008).

Payment to ecosystem services

Upon observation, we noticed various stakeholders' concerned and involved which includes individuals, businesses, organizations and other relevant organizations involved directly or indirectly. After identification process, selection was done based on top down approach on use and/or management of wetland ecosystem (Table 3).

We noticed that local communities has some knowledge about payment to ecosystem services and have been practicing it to some extent. Bandevi Barandabhar community forest user's group members have been practicing the concept to relish the services from Bishajari Lake and associated wetland area. This scheme offer the community forests members a critical incentive to change the livelihood practices and encourage stewardship. The schemes mainly offer a means to concurrently provide multiple nonfinancial benefits, directly leading to longer-term financial benefits for users group, and often exceed the value of the financial payment.

Table 1: Ecosystem services generated by Bishajari Lake and Associated Wetland Area, Chitwan

Provisioning services	
Fishes	*Ctenopharyngodon idella* Valenciennes, *Hypophthalmichthys molitrix* Valenciennes, *Aristichthys nobilis* J. Richardson, *Labeo rohita* Hamilton, *Macrobrachium rosenbergii* de Man , *Channa striata* Bloch, *Puntius sophore* Hamilton, *Anguilla bengalensis* Gray, *Channa orientalis* Bloch & Schneider, *Clarias batrachus* L., *Heteropneustes fossilis* Bloch, *Channa stewartii* Lambert
Fruits	*Callicarpa macrophylla* Vahl, *Mangifera indica* L., *Cleistocalyx operculatus* (Roxb.) Merr. & Perry, *Cucumis melo* var. *agrestis* Naud., *Ficus hispida* L., *Ficus semicordata* Buch.-Ham. ex J. E. Smith, *Melothria heterophylla* (Lour.) Cogn., *Phyllanthus glaucas* Wall. ex Muell.-Arg., *Physalis divaricata* D. Don., *Solanum nigrum* L. *Sygyzium cumini* (L.) Skeels, *Zizyphus nummularia* (N. Burm.) Wt. & Arn., *Zizyphus rugosa* Lam., *Cleistocalyx operculatus* (Roxb.) Merr., *Terminalia chebula* Retz., *Terminalia bellirica* (Gaertn.) Roxb., *Ananas comosus* (L.) Merr.
Timber	*Shorea robusta* Roth, *Dalbergia sisoo* Roxb., *Bombax ceiba* L., *Melia azedarach* L., *Terminalia alata* Heyne ex Roth, *Ougeinia ozgeninsis* (Roxb.) Hochr., *Bambosa* sp. (L.) Voss, *Acacia catechu* (L.) Willd., ~~Oliv.~~, *Artocarpus lakoocha* Buch.-Ham., *Artocarpus heterophyllus* Lam., *Dalbergia latifolia* Roxb., *Cleistocalyx operculatus* (Roxb.) Merr.
Fodder	*Melia azedarach* L., *Leucaena lucocephala* (Lam.) de Wit, *Artocarpus heterophyllus* Lam., *Mangifera indica* L., *Artocarpus lakoocha* Buch.-Ham., *Bombax ceiba* L., *Ficus recemosa* L., *Myrica esculenta* L., *Ficus bengalensis* L., *Ficus religiosa* L., *Terminalia alata* Heyne ex Roth, *Deerigia celosioides R. Br.*, *Spondias pinnata* L., **Ghodedhupi**
Vegetables	*Ricinus communis* L., *Adhatoda vasica* Nees., *Solanum torvum* L., *Momordica charatia* L., *Chenopodium album* L., *Solanum surattens* L., *Amaranthus viridis* L., *Ophioglossum vulgatum* L., *Amaranthus spinosus* L., *Solanum nigrum* L., *Asparagus racemosus* Willd., *Costus speciosus* (Koen. ex Retx.) Smith., *Oenanthe javanica* DC., *Diplanzium esculentum* (Retz.) Sw., *Corchorus aestuans* L., *Nasturtium officinale* R. Br., *Urtica dioica* L., *Dillenia pentagyna* Roxb., *Semicarpus anacardium* L. f., *Solanum aculeatissium* Jacq.
Medicinal plants	*Centella asiatica* (L.) Urban, *Scoparia dulcis* L., *Ananas comosus* (L.) Merr., *Piper nigrum* L., *Amaranthus spinosus* L., *Zizyphus nummularia* Lam., *Capsicum frutescens* L., *Adhatoda vasica* L., *Piper longum* L., *Acorus calamus* L., *Curcuma longa* L., *Solanum tuberosum* L., *Chenopodium album* L., *Ocimum basilicum* L., *Datura metel* L., *Chromalaena odorata*, *Ageratum houstanianum* Mill. *Mallotus philippensis* Lam., *Euphorbia hirta* L., *Psidium guajava* L., *Oxalis corniculata* L., *Carica papaya* L., *Abelmoschus esculentus* (L.) Moench., *Calotropis gigantea* L., *Semecarpus anacardium* L.f., *Artemisia indica* L., *Tinospora cordifolia* (Thunb.) Miers., *Terminalia bellirica* (Gaertn.) Roxb.
Regulating services	
Climate regulation	The vegetation cover involves in evapotranspiration to regulate microclimate such as temperature, precipitation
Water regulation	Woodland Bishajari lake regulates run off and river discharge, ground water recharge
Erosion control	Role of woodland in holding soils; vegetation cover to prevent wind, sheet and gully erosion
Supporting services	
Nursery	Growth place for Sal, Saj, Harro trees, Suitable reproduction habitat for fish, Snails, Crabs, and many birds
Refugium	Habitat for aquatic organisms, Phytoplankton and Zooplanktons, wild plants, wild birds, residential birds, and a variety of mammals
Cultural services	
Recreational	Opportunities for tourism and recreational activities
Spiritual	Traditional beliefs, religious significance
Research & Education	Study area for scientific community, Opportunities for formal and informal education and trainings

Table 2: Valuation of ecosystem services generated by Bishajari lake and associated wetland area, 2012.

Ecosystem services	Annual benefits assessed (NRs.)	Gap/research/note
Food (e.g. crops, fruit, fish, etc.) a. Fish	185,000	Value not used = Employment in farms/wetlands
Fibre and fuel (e.g. timber, wool, etc.) a. Wood b. Thatch c. Others	 2,300,000 200,000 545,500	Value not used = Employment in forest lots
Genetic resources	Net value not assessed	
Air quality regulation	It was not possible to value this ecosystem service	Quantification and valuation of air quality regulation
Climate regulation	No net value ascribed	Microclimate effects not quantified Implications for palustrine and locustrine marsh not quantified
Hydrology regulation	Benefit not assessed	Quantification of contribution to hydrology
Nursery and refugium	Benefit not assessed	
Recreation and spiritual a. Tourist entry	 198,500	 Purpose of visit and extent of stay
Research and education	No net value ascribed	Quantification of totals studies and research done in the wetland area.

Table 3: Different stakeholders group and their responsibilities towards conservation and management of Bishajari Lake and associated wetland area, 2012.

Stakeholder group	**Key stakeholders**	**Responsibilities/interests**
Park managers and staff	Park Warden, experts and staffs	Conservation of wildlife and ecosystem
Communities	Residents adjacent to the wetland area	Use of natural resources and wetland ecosystem services
Businesses and enterprise	Hotels, Resorts/lodges, Coke Factory	Making business from tourists and visitors and marketing ecosystem services
Local Government	District Development Office, Municipality Office, DFO, DSCO	Maximizing economic benefit Protection and conservation of Natural resources & ecosystem, looking legal aspects and policy support
Environmental NGOs	Different NGOs and INGOs	Conservation, capacity building, advocacy and research

Table 4: Investment by Bandevi Community Forest Users' Group as payment to ecosystem services generated by Bishajari Lake and associated wetland area, 2012.

Investment on	Amount (NRs.)
a. Salary of forest guard and management officials	333,500
b. Incentives on biogas	85,000
c. Incentive on tap construction	60,000
d. Incentives on toilet construction	70,000
e. Scholarship for minorities	25,000
f. Management and protection of wetland area	328,823
g. Others	546,679
Total	

Note: They have been obtaining incentives on annual basis numbered Rs. 100,000 from MP development fund, Rs. 727,119 from ministry of local development, Rs. 187,435 from peace Ministry and Rs. 191,000 from District Development Committee. However, detail report was not available on this regard.

Types of benefits/payments

Among the various services generated, the management committees seek to or are making payments on various headings, which is shown in the Table 4. Most benefits are in the form of services, especially professional support, capacity building, incentives, scholarship and technical assistance.

Defining the category of payment is done to some extent around Bishajari Lake and associated wetland area linking the wetland to various dynamism for conservation and management as well. Generally, more quantitative causal analyses of PES effectiveness is needed, particularly since their use at local and national levels is on the rise (Greig-Gran and Porras, 2012). Scaling up PES may increase the ability to identify and mitigate leakage effects (Robertson and Wunder, 2005).

Distribution of benefits

Upon study, we noticed the distribution mechanism was via community based institutions like farmers group. There are various schemes for making direct payments to beneficiaries. As Coca Cola company is also one of the important stakeholders the payment is done on annual basis, which mainly supports in conservation aspects of wetland such as cleaning of wetland and safeguarding it from different invasive species e.g. *Eichhornia.*

Challenges and conflicts

The main challenges was financial constraints (e.g. lack of funding and proper accounting), institutional constraints (e.g. negligence by government agencies, lack of proper human resources), or behavioral constraints (e.g. attitudes and unsustainable practices). On the specific conflicts most involved conflicts between user groups and frustration by community forest members downstream that farmers.

Condition and trends of selected ecosystem services provided by wetland

The majority of respondents feel that the quality of ecosystem services derived from Bishajari Lake ecosystem is deteriorating which was proven by their responses. Some 58.5% of respondents felt that the trends of services derived from Bishajari Lake are rapidly degrading while 25.6% felt it is slowly degrading, 10.2% felt that the trends of ecosystem services received are constant and 5.7% felt it is still good as shown in figure 1. Talking about the effect of this change 31.7% stressed on food, 22% on diseases, 19.5% on flood and 14.6% on migration. About 48.78 % of respondents stressed the cause for this change on climate change, 19.51 % on increased demand for food, 17.07% on population growth and 14.63% concentration of land. While talking about the processes driving this change, 43.9% of respondents voted for climate change, 36.6% on deforestation, 14.6% on water pollution and 4.9% on fragmentation. It is shown in the Fig. 2:

This finding coincided with Markandya (2012) stating that the planet has lost 50% of its wetlands, 40% of its forests and 35% of its mangroves and around 60% of global ecosystem services have been degraded in just 50 years and it is mainly due to coupled interaction of climate change and anthropogenic activities.

All the respondents feel that their life is affected by ecosystem change. Talking about the causes of this change 32% stressed on food, 22% on diseases, 19% on flood and 15% on migration. Moreover, a total of 22% voted for population growth and over extraction as driver of ecosystem change where as 14.6% for pollution, 7.3% for fragmentation and 34.1% for climate change.

Williamson *et al*. (2009a) and Williamson *et al.* (2009b) believe that the lakes are excellent indicators of climate change whose primary concern to humans include expanding areas of low oxygen ("dead zones"), harmful algal blooms (HABs) and depressed fisheries production. There is also unequivocal evidence that climate change is occurring and having impacts on biodiversity (IPCC, 2007). Also climate driven changes in the functioning of ecosystems are very likely to result in altered vegetation communities, shifts in major biome boundaries, and changes in habitat for animal species (IPCC, 2007; Bergengren *et al.*, 2011; Gonzalez *et al*., 2010; Sitch *et al*., 2008).

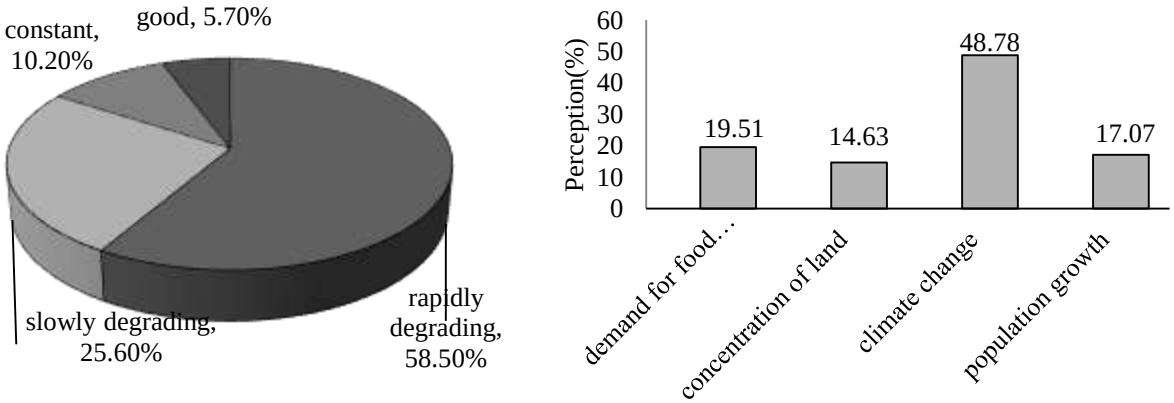

Fig. 2. Perception of respondents on status of ecosystem services (left) and causes of change (right) at Bishajari Lake and associated wetland area, Chitwan, 2012

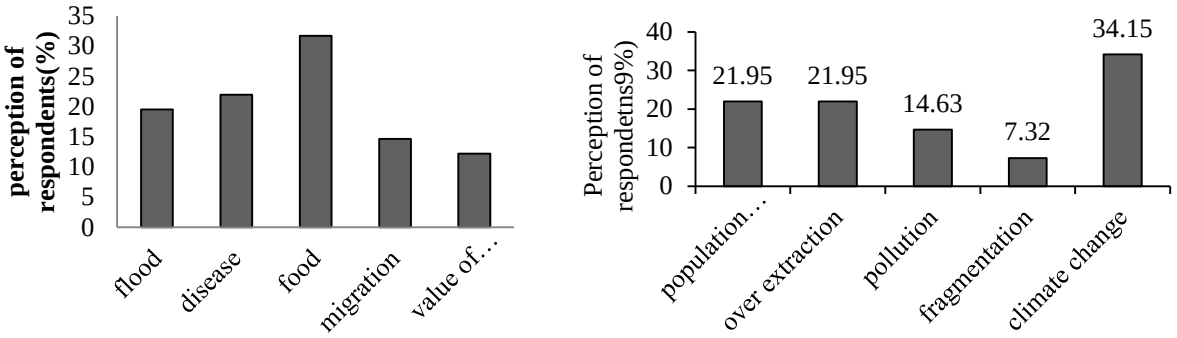

Fig. 3. Perception of respondents on services affected most (left) and driver of change in services (right) at Bishajari Lake and associated wetland area, Chitwan, 2012

Conclusion

Wetlands being one of the most productive ecosystems of the planet deliver a wide range of goods and services to people residing around it. It supports the livelihoods of billions of people by providing different types of ecosystem services directly or indirectly. Nepal being one of the richest countries in water resources, if concept of ecosystem services and payment to ecosystem services are taken into considerations, the decision making can benefit a lot from it. The study both qualitative and quantitative data, realistic synthesis approach was used in data collection and analysis. During this coarse identification of ecosystem services and subsequent identification of stakeholders were done using the very concept of ecosystem services approach. The Bishajari and associated wetland area which is also one of the nine Ramsar sites of Nepal, also provides good and convincing way of livelihood for local communities residing at around the area as it is highly diverse area and provides lot of provisional services which the people can cash it into income for better way of living. To safeguard the wetland ecosystem and for proper management, sustainable harvesting of wetland resources and the concepts of payment to ecosystem services used can be done. For this, the stakeholders involved in different areas of wetlands are to be identified and there should be clear demarcation on roles and responsibilities of each stakeholders' group is to be done.

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References

Asquith NM, Vargas MT, and Wunder S (2007) Selling two environmental services: In-kind payments for bird habitat and watershed protection in Los Negros, Bolivia. *Ecological economics*. **2008**: 675-684.

Bergengren JC, Waliser DE, and Yung YL (2011) Ecological sensitivity: a biospheric view of climate change. *Climatic Change* **107**: 433-457. DOI: 10.1007/s10584-011-0065-1

CGIAR/CIAT (2013) Marksim weather generator. Available at http://gismap.ciat.cgiar. org/ MarkSimGCM (Retrieved on November 28, 2012).

Daily G (1997) *Nature's services: societal dependence on natural ecosystems*. Washington, DC: Island Press.

Dangol DR (2002) Economic use of forest plant resources in western Chitwan, Nepal. *Banko Janakari* **12** (2): 56-64.

Dixon-Woods M, Agarwal S, Jones D, Young B, and Sutton A (2005) Synthesizing qualitative and quantitative evidence: a review of possible methods. *Journal of Health Services Research & Policy* **10**:45-53. DOI: 10.1258/1355819052801804

Gonzalez P, Neilson RP, Lenihan JM, and Drapek RJ (2010) Global patterns in the vulnerability of ecosystems to vegetation shifts due to climate change. *Global Ecology and Biogeography* 19: 755-768. DOI: 10.1111/j.1466-8238.2010.00558.x

Grieg-Gran M and Porras I (2012) Paying for watershed services: an effective tool in the developing world? IIED Briefing Paper.

IPCC (2007) Climate Change Adaptation and Vulnerability, Summary for Policymakers, Intergovernmental Panel on Climate Change, Geneva, Switzerland.

Markandya A (2012) Value of Biodiversity and Ecosystem Services in South Asia and India: Past, Present and Future. Bath University (UK) and BC3 (Spain).

MEA (2005) Ecosystems and Human Well-being: A Framework for Assessment. Millennium Ecosystem Assessment. Island Press, Washington, D.C.

Revenga C and Kura Y (2003) Status and Trends of Biodiversity of Inland Water Ecosystems. Secretariat of the Convention on Biological Diversity, Montreal, Technical Series no. 11. 120 P

Robertson M, and Wunder S (2005) Payments for environmental services: Some nuts and bolts. CIFOR Occasional paper No. 42. Bogor, Indonesia.

Sitch S., C. Huntingford, N. Gedney, P.E. Levy, M. Lomas, S.L. Piao, R. Betts, P. Ciais, P. Cox, P. Friedlingstein, C.D. Jones, I.C. Prentice and F.I. Woodward. 2008. Evaluation

of the terrestrial carbon cycle, future plant geography and climate-carbon cycle feedbacks using five Dynamic Global Vegetation Models (DGVMs). *Global Change Biology* **14**: 2015- 2039. DOI: 10.1111/j.1365-2486.2008.01626.x

Tharme R, Finlayson M and McCartney M (2008) Water Policy briefing. International Water Management Institute.

Turner NJ, Gregory R, Brooks C, Failing L and Satterfield T(2008) From invisibility to transparency: identifying the implications. *Ecology and Society* **13**(2): 7. URL: http://www.ecologyandsociety.org/vol13/iss2/art7/

Williamson CE, Saros JE, and Schindler DW (2009a) Climate change: Sentinels of change. *Science* **323**: 887-888.

Williamson CE, Saros JE, Vincent WF, and Smol JP (2009b) Lakes and reservoirs as sentinels, integrators, and regulators of climate change. *Limnology Oceanography*. **54**: 2273- 2282. DOI: 10.4319/lo.2009.54.6_part_2.2273