

PROCEEDINGS INTERNATIONAL LAKE CONFERENCE



2018

Sustainable Utilization of Lake Resources



Organized by
Government of Nepal
Ministry of Culture, Tourism and Civil Aviation
National Lake Conservation Development Committee



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Sustainable Utilization of Lake Resources

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गणेशप्रसाद तिम्बिल्सिना
अध्यक्ष

राष्ट्रिय सभा



फोन : ०१-४२११७५६

फ्याक्स : ०१-४२११७५३

सिंहदरबार, काठमाडौं, नेपाल

उद्घाटन मन्तव्य

यस अन्तर्राष्ट्रिय ताल-सम्मेलनका अध्यक्षज्यू, अतिथिज्यूहरु, विभिन्न देश विदेशबाट आउनुभएका आदरणीय पाहुनाहरु, संघ संस्थाका प्रतिनिधिज्यूहरु, ताल-उपभोक्ता समितिका प्रतिनिधिज्यूहरु, पत्रकार मित्रहरु, विदीबहिनी तथा दाजुभाइहरु !

नेपाल र नेपालीलाई मात्र नभई संसारभरका ताल संरक्षणकर्मीहरुको लागि यस अन्तर्राष्ट्रिय ताल सम्मेलन महत्वपूर्ण तथा ऐतिहासिक कार्यक्रम हो । नेपाल सरकार, ताल संरक्षण क्षेत्रमा सचेत भएकोले नै वि.सं. २०६३ सालमा राष्ट्रिय ताल संरक्षण विकास समितिको गठन भएको हो । यो ताल संरक्षणको लागि ऐतिहासिक कदम हो ।

विश्वमा ताल तथा सिमसारहरुले महत्वपूर्ण स्थान ओगटेका छन् । विश्वमा तालहरुको नामबाट देशको नामसमेत बनेको छ । उदाहरणको लागि फिनल्याण्डलाई लिन सकिन्छ । फिनल्याण्डले स्थानीय भाषामा ताललाई जनाउँछ । त्यसैले यस देशलाई तालहरुको देश भनिन्छ । नेपालमा पनि धेरै ताल तथा सिमसारहरु छन् । नेपालको ठूलो ताल रारा, विश्वको सर्वोच्च स्थानमा रहेको तिलिचो ताल, धार्मिक महत्वको रसुवा जिल्लाको गोसाइकुण्ड, मुस्ताङको दामोदरकुण्ड, पोखरामा रहेको फेवाताल, बेगनास, रुपाताल लगायत ९ तालहरु, कैलालीको घोडाघोडी ताल, इलामको माईखरी, चितवनको बिसहजारी ताल, कपिलवस्तुको जगदिशपुर जलाशय लगायत तराईका जिल्लाहरुमा समेत धेरै तालहरु पर्दछन् ।

विश्वभर ताल र सिमसार संरक्षण गर्नको लागि विभिन्न समस्याहरुको सामना गर्नु परेको छ । यस्ता किसिमका समस्या नेपालका तालहरुमा पनि रहेका छन् । ताल संरक्षणको क्षेत्रमा विश्व भरका समाज, नागरिकलगायतका संघ संस्थाहरु सक्रिय छन् । यस किसिमको सक्रियतामा भिन्नता होला तर सबै जनाको ज्ञान तथा अनुभव साटासाट गर्नको लागि राष्ट्रिय ताल संरक्षण विकास समितिद्वारा आयोजित यस अन्तर्राष्ट्रिय ताल सम्मेलन एक महत्वपूर्ण हुने मैले विश्वास गरेको छु । यस सम्मेलन भइरहेको स्थान, पर्यटकीय नगरी पोखराको फेवातालले के अनुभूति गरिरहेको होला ? अनुमान गरौं त ! वास्तवमा अहिले यस्तो सम्मेलन भइरहदा यो तालले आफूमाथिको अतिक्रमण बढिरहेको अवस्थामा यहाँ आएका पाहुनाहरुले के सोचिरहेका होलान भनेर उसले आफ्ना अतिक्रमणको पीडा पनि अनुभूती गरिरहेको होला । साथै आशा पनि गरिरहेको होला कि यहाँ आउने व्यक्तिले संसार भरि के म जस्तै अतिक्रमणमा परेका तालहरुको र मेरो पनि उद्धार गरिदिनेछन् र अब स्वच्छ भएर अबै आफ्नो ठाउँ बढाउन पाउने छु ।

मलाई धेरै खुसी लागेको छ कि राष्ट्रिय ताल संरक्षण विकास समितिले आयोजना गरेको यस अन्तर्राष्ट्रिय ताल सम्मेलनमा देश विदेशमा रहेका ताल तथा सिमसारहरुको वर्तमान अवस्था, समस्या, संरक्षण र चुनौतीहरुको अनुभव आदानप्रदान गर्न विभिन्न देश विदेशका ताल तथा सिमसार सम्बन्धी कार्यपत्रहरुलाई सम्मेलनमा सममावेश गरिएको छ । यी कार्यपत्रहरु ताल तथा सिमसार संरक्षण र विकासको लागि महत्वपूर्ण साबित हुनेछन् साथै सम्मेलनबाट जारी भएको घोषणापत्रले पनि हामी सबैको सामुहिक प्रयासको लागि प्रेरणाको स्रोत हुनेछ । अन्तर्राष्ट्रिय अनुभवबाट हाम्रा ताल तलैयाको संरक्षण, व्यवस्थापन र दिगो विकासका लागि एउटा कोसेढुङ्गा साबित हुनेछ, भन्ने मलाई पूर्ण विश्वास छ । यो सम्मेलनको पूर्ण सफलताको कामना गर्दै यो महान् कार्यक्रममा आयोजक राष्ट्रिय ताल संरक्षण विकास समितिले आज मलाई उद्घाटन गर्ने अवसर दिएकोमा हार्दिक धन्यवाद दिन चाहान्छु । साथै यस कार्यक्रमको लागि सबै क्षेत्रबाट पूर्ण रुपमा सहयोग मिल्ने छ र राष्ट्रिय ताल संरक्षण विकास समिति सबैको धन्यवादका पात्र बन्ने छ ।

वर्तमान नेपाल सरकारले **समृद्ध नेपाल, सुखी नेपाली**को अभियान ल्याएको छ । यो एक महत्वपूर्ण र ऐतिहासिक आवश्यकता हो । जब यो व्यवहारमा कार्यान्वयन हुन्छ, नेपालका तालहरुको संरक्षण, विकास र प्रचारप्रसारले लाखौं विदेशी पर्यटकहरु देश भित्राउन सकिनेछ । जसले स्थानीय स्तरका ताल उपभोक्ताहरुको जीविकोपार्जनमा टेवा पुर्‍याउनेछ, भन्ने विश्वासका साथै यहाँहरुबाट ताल संरक्षणको विषयमा महत्वपूर्ण निचोड आउनुका साथै पोखराको मनोरम दृश्यबाट यस सम्मेलन भव्यताका साथ सम्पन्न हुनेछ र समग्रमा नेपालको पर्यटन प्रवर्द्धनको लागि पनि प्रचारप्रसार गर्नुहुनेछ । धन्यवाद, जय ताल संरक्षण ।

गणेशप्रसाद तिम्बिल्सिना

अध्यक्ष

राष्ट्रिय सभा



मुख्य मन्त्री



गण्डकी प्रदेश

पोखरा, नेपाल

सम्पर्क नं. ०६१-४६७८५१

अन्तर्राष्ट्रिय ताल सम्मेलन २०१८

मन्तव्य

राष्ट्रिय ताल संरक्षण विकास समितिद्वारा आयोजित अन्तर्राष्ट्रिय ताल सम्मेलन समारोहका अध्यक्षज्यू, कार्यक्रमका अध्ये अतिथिज्यूहरु तथा अन्य विभिन्न क्षेत्रबाट सहभागी हुनु भएका भद्र महिला तथा सज्जनवृन्द ।

नेपाल सरकार मातहतको राष्ट्रिय ताल संरक्षण विकास समितिद्वारा नौ तालको सुन्दर शहर पोखरामा अन्तर्राष्ट्रिय ताल सम्मेलन आयोजना गरेकोमा हृदय देखि नै धन्यवाद दिन चाहन्छु । तालतलैया तथा सिमसार क्षेत्रहरु प्रकृति प्रदत्त उपहारहरु हुन् । यिनीहरु पृथ्वीका गहना हुन् । यी तालतलैया तथा सिमसार क्षेत्रहरु प्राकृतिक जलमण्डारका विविध रुपहरु मध्ये एक हुन् ।

प्राकृतिक र मानवीय कारणले विश्वव्यापी रुपमा ताल तलैया र सिमसार क्षेत्रहरुको संरक्षण र विकास विस्तार हुने स्थिति घट्दो र भैरहेका तालतलैया र सिमसार क्षेत्रहरुको विनाश हुने कम दिनप्रतिदिन द्रुतगतिमा बढ्दो छ । आज हामी अवस्थित पृथ्वीका अत्यन्त सुन्दरतम तालतलैयाहरुको आकर्षणलाई वेवास्ता गरि तिनको भविष्य माथी खेलबाड गरिरहेका छौं । पूर्याका यी मुल्यवान उपहार हाम्रा सन्ततीलाई हस्तान्तरण गर्न सक्ने नसक्ने दोसाधमा हामी उभिरहेका छौं । यदि यहि क्रमलाई यथास्थितिमा छाड्ने हो भने भोलिका दिनमा हाम्रा सन्ततिले ताल तलैया र सिमसारको बारेमा पढ्न मात्र पाउने छन् तर देख्न भने पाउने छैनन् । यी कुरालाई मनन गरेर यिनको योजनावद्ध सिमाङ्कन, संरक्षण र विकास गर्नका लागि भागिरथ प्रयत्न गर्नु हाम्रो कर्तव्य हो ।

यस राष्ट्रिय ताल संरक्षण विकास समितिको पहलमा पोखरा उपत्यकाको ९ ओटै तालहरुलाई एकिकृत रुपमा २०७२ सालमा नेपालको दशौं रामसार सूचिमा सूचीकृत गराई ती तालहरुलाई अन्तर्राष्ट्रिय स्तरमा पहिचान गराएको छ । यसरी नै यस राष्ट्रिय ताल संरक्षण विकास समितिले नेपालका अरु तालहरुको पनि अध्ययन तथा विभिन्न माध्यमद्वारा नेपालका ताल तलैया तथा सिमसारहरुलाई अन्तर्राष्ट्रिय स्तरमा पहिचान गराउदै जाने कुरामा हामी पूर्ण रुपमा विश्वस्त छौं ।

प्रकृतिलाई माया गर्दै समृद्धि हासिल गर्ने हाम्रो अभियानमा राष्ट्रिय ताल संरक्षण विकास समितिले आयोजना गरेको यो सम्मेलनले महत्वपूर्ण भूमिका खेलेछ । सहभागितामूलक विकासको माध्यमबाट हामी अगाडि बढ्न खोजेका हुनाले यस सम्मेलन अत्यन्तै महत्वपूर्ण छ । यस सम्मेलनबाट निस्किएको निचोड पक्कै पनि राष्ट्रिय तथा अन्तर्राष्ट्रिय ताल तथा सिमसार क्षेत्रहरुलाई संरक्षण गरी प्रभावकारी बनाउन फलदायी हुनेछ । यस अन्तर्राष्ट्रिय ताल सम्मेलन २०१८ को घोषणा पत्र नेपालका तालतलैया तथा सिमसारको संरक्षण र उपयोगिताको संबन्धमा अवश्यनै फलदायी हुनेछ र हरेक तालतलैया तथा सिमसार संरक्षण, विकास, प्रबर्द्धन र उपयोग गर्न यस सम्मेलन कोशेदुङ्गा सावित हुनेछ भन्ने विश्वास गर्दै ताल, सिमसारको संरक्षण र सम्बर्द्धनको लागि आयोजित यस सम्मेलनमा तालतलैया र सिमसार क्षेत्र जोगाउने अभियानमा विदेश तथा स्वदेशबाट आउनुभएका पाहुनाहरुलाई धेरै धन्यवाद दिन चाहन्छु ।

पृथ्वी सुब्बा गुरुङ्ग
मुख्यमन्त्री



प्रदेश सरकार



प्रदेश सरकार
उद्योग, पर्यटन, वन तथा वातावरण मन्त्रीको
निजी सचिवालय
गण्डकी प्रदेश
पोखरा, नेपाल

निजी सचिवालय

माननीय विकास लम्साल

उद्योग, पर्यटन, वन तथा वातावरण मन्त्री

पोखरा, नेपाल

पत्र संख्या:

चलानी नं.:

मन्तव्य

मिति:

२०७५।०१।३०

माननीय मन्त्री, विकास लम्साल, उद्योग, पर्यटन, वन तथा वातावरण मन्त्रालय, गण्डकी प्रदेश

यो दुई दिने अन्तर्राष्ट्रिय ताल सम्मेलनमा सहभागी भई महत्वपूर्ण निष्कर्ष निकाल्नु भएकोमा म यहाँहरूलाई हार्दिक धन्यवाद दिन चाहान्छु । यहाँ निकै बौद्धिक छलफल गर्नु भएको छ । विद्वान प्रोफेसर नाकामुरा ताल सम्बन्धी विज्ञ हुनुहुन्छ र उहाँ लगायत विशिष्ट व्यक्तित्वहरुको सहभागीता नै हाम्रो लागि एउटा ठूलो उपलब्धि भएको छ । यहाँबाट जुन निष्कर्ष निकाल्नु भएको छ, त्यो हामीलाई मार्गदर्शन हुनेछ । त्यो निष्कर्षलाई हामी कसरी व्यवस्थित गर्ने, कसरी कानूनसम्मत बनाउने र कसरी नियमन गर्दै लैजाने, तालहरु कसरी बने, कसरी विकास भए, कसरी मानवले त्यसको संरक्षणको लागि योगदान गरे, धेरै विषयमा तपाईंहरुले छलफल गर्नु भयो र हामीलाई ज्ञान दिनुभयो ।

पानी हाम्रो जीवनसँग जोडिएको विषय हो । पानीलाई कसरी संरक्षण गर्ने, कुवालाई कसरी संरक्षण गर्ने, पोखरीलाई संरक्षण गर्ने कुराहरुमा हामीलाई बुझ्ने मौका मिलेको छ । यसले प्रदेशका ताल संरक्षणमा ठूलो सहयोग पुऱ्याउने छ भन्ने हाम्रो विश्वास छ । यी सबै कुराहरुलाई हामी व्यवस्थित गरेर कानुन बनाएर अगाडि बढ्नेछौं ।

सम्मेलनको सिलसिलामा तपाईंहरुलाई केही अप्ठ्यारो, गाह्रो परेको भए त्यसलाई विसिदिनुहुनेछ र अन्तर्राष्ट्रिय डेलिगेट्सहरुले पोखराजस्तो एउटा सुन्दर शहरमा भएको सम्मेलनमा सहभागी भई ठूलो उपलब्धि हासिल गरेको कुरा तपाईंहरुले लिनुभएको छ भन्ने हामीले लागेको छ । म उद्योग, पर्यटन, वन तथा वातावरण मन्त्रालयको तर्फबाट सबैलाई हार्दिक धन्यवाद दिन चाहान्छु । हामी अर्को पाँच वर्षभित्र फेरि यस्तै सम्मेलन गर्नेछौं र त्यो बेलामा तपाईंहरुले अहिले खुम्चेको ताल यति राम्रो भएछ, तालहरुको धेरै विकास भएछन भन्ने कुरा देखाउन सम्मेलन पश्चात उपलब्धि देखिने गरी हामी काम गर्नेछौं । तपाईंहरुलाई यहि विश्वास दिलाउँदै सम्पूर्ण सहभागीहरुलाई हार्दिक धन्यवाद दिदै म मेरो भनाईलाई यहि अन्त्य गर्न चाहान्छु । धन्यवाद

म.स.ल.

माननीय विकास लम्साल
मन्त्री
उद्योग, पर्यटन, वन तथा वातावरण



संस्कृति, पर्यटन तथा नागरिक उडड्यन मन्त्रालय
राष्ट्रिय ताल संरक्षण विकास समिति

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पत्र संख्या :- ७५/७६

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प्राक्कथन

नेपालका तालहरूको संरक्षण, विकास, विस्तार, प्रवर्द्धन र उपयोगसँग प्रत्यक्ष र अप्रत्यक्ष सरोकार राख्ने कामकारवाहीको सन्दर्भमा राष्ट्रिय ताल संरक्षण विकास समितिको गठन, यसका उद्देश्य, यसले हाल सम्म गरेका महत्वपूर्ण कामहरू देखि समितिले नेपालमा पहिलो पटक आयोजना गरेको अन्तर्राष्ट्रिय ताल सम्मेलनको बारेमा समेत शृङ्खलारूपमा संक्षिप्त विवेचनात्मक चर्चाहरू प्राक्कथनको रूपमा यस अन्तर्राष्ट्रिय ताल सम्मेलन २०१८ को कार्यसम्पादित विवरण पुस्तिका मार्फत समितिको तर्फबाट पेश गर्न पाउँदा खुसीको अनुभूतिका साथ प्राक्कथन लेखन प्रारम्भ गर्दछु।

समितिको गठन : नेपालको विभिन्न धरातलमा विद्यमान ताल, दह, कुण्ड, ऐतिहासिक पोखरी एवं सिमसार क्षेत्रहरू हाम्रा प्राकृतिक, आध्यात्मिक तथा सांस्कृतिक विकास र सभ्यताका धरोहर हुन्। यस वास्तविकतालाई मध्यनजर गरेर नेपाल सरकारले २०६३ साल फाल्गुन २३ गतेको मन्त्रिपरिषदको निर्णय अनुसार नेपालका सम्पूर्ण ताल, दह, कुण्ड, पोखरी एवं सिमसार क्षेत्रहरूको संरक्षण, संवर्द्धन र उक्त क्षेत्रहरूको जैविक विविधता, पारिस्थितिक प्रणाली र सुन्दरताको संरक्षण तथा विकास गर्नका लागि विकास समिति ऐन २०१३ अर्न्तगत राष्ट्रिय ताल संरक्षण विकास समितिको गठन गरिएको हो।

समितिको उद्देश्य : नेपालका ताल तथा सिमसार क्षेत्रहरूको संरक्षण विकास र उपयोग सम्बन्धि नीति-नियमहरू तर्जुमा गर्दा नेपाल सरकारलाई आवश्यक परामर्श दिने। नेपाल भित्र रहेका तालहरूको तथ्याङ्क संकलन गरी ती तालहरूले चर्चेका जग्गा एवं चल/अचल सम्पतिहरूको अभिलेख अद्यावधिक राख्ने। तालहरूको धार्मिक, सांस्कृतिक, पर्यटकीय, जैविक विविधता तथा प्राकृतिक महत्वको आधारमा वर्गिकरण गरी तिनको संरक्षण, प्रवर्द्धन र विकास गर्ने। ताल संरक्षणसँग सरोकार राख्ने अन्तर्राष्ट्रिय संघ, संस्थाहरूसँग समन्वय गरी नेपालका तालहरूलाई अन्तर्राष्ट्रिय क्षेत्रमा प्रवर्द्धन गर्ने यस समितिको प्रमुख उद्देश्यहरू हुन्। यी उद्देश्य र लक्ष्यहरूलाई साकार बनाउने कार्यमा राष्ट्रिय ताल संरक्षण विकास समितिले महत्वपूर्ण भूमिका निर्वाह गर्दै आइरहेको छ।

समितिले सम्पन्न गरेका महत्वपूर्ण कार्यहरू : राष्ट्रिय ताल संरक्षण विकास समितिले नेपालमा रहेका तालहरूको संख्या एकिन गर्नको लागि करिब सात सय बटा टोपो नक्साहरूको अध्ययन गरि नेपाल सरहद भित्र ५,३५८ बटा तालहरू रहेको तथ्याङ्क सार्वजनिक गरेको छ। नेपालका तालहरूको संरक्षण र पर्यटन प्रवर्द्धनका लागि राष्ट्रिय ताल कार्यनीति योजना तयार गरि स्वीकृतिको लागि संस्कृति, पर्यटन तथा नागरिक उडड्यन मन्त्रालयमा पेश गरेको छ। नेपालका ६२ बटा जिल्लाहरूमा अवस्थित तीन हजार मिटर भन्दा कम उचाईमा रहेका तालहरूको विस्तृत विवरण सहितको अभिलेख तयार गरि सकेको र बाँकी जिल्लाहरूमा रहेका तालहरूको विस्तृत विवरण सहितको अभिलेख पनि यथाशिघ्र तयार गर्ने लक्ष्य राखेको छ। यस विकास समितिको पहलमा पोखरा उपत्यका भित्र रहेका नौ बटा तालहरूलाई एकिकृत रूपमा रामसारमा सुचिकृत गर्नको लागि स्वीजरल्याण्डको रामसार सचिवालयको साना अनुदान सहयोग मार्फत तालहरूको प्राविधिक अध्ययन गरि Ramsar Information Sheet (RIS) भरी सन् २०१६ मा एकिकृत रामसार क्षेत्रको रूपमा सुचिकृत भएको छ। पर्यटकीय महत्वका तालहरूको दिगो संरक्षण र पर्यटन प्रवर्द्धन गर्नका लागि रुपन्देहीको गैडहवा ताल, रुकुमको स्यापू ताल र वारलुङको गाजा दहको व्यवस्थापन योजना तयार गरेको छ। त्यस्तै तालहरूको प्रदुषण स्थिति न्यूनिकरण गर्नका लागि सुनसरीको तालतलैया, मोरङको बेतना ताल र धनकुटाको राजारानी तालहरूको उच्चपोषण म्यापिङ कार्य सम्पन्न गरेको छ। २०७३ साल असोज ३ देखि ७ गतेसम्म मुगु जिल्ला अवस्थित रारा तालको पर्यटन प्रवर्द्धनका लागि रारा ताल परिसरमा समितिले पर्यटन मन्त्रालय र राष्ट्रिय योजना आयोगका प्रतिनिधिहरू तथा नेपाल पर्यटन बोर्ड, विभिन्न राजनीतिक दलका प्रतिनिधिहरू, पर्यटन संघ संस्थाका प्रतिनिधिहरू, पत्रकार तथा नागरिक समाजको समेत सहभागितामा बृहत सार्वजनिक भेला आयोजना गरि "रारा तालको संरक्षण र पर्यटन प्रवर्द्धन



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विषयक"अर्न्तक्रिया कार्यक्रम सहित राराक्षेत्रको पर्यटन प्रवर्द्धनका लागि डुङ्गा लगायत जलयात्राका सुरक्षा सामाग्रीहरु रारा राष्ट्रिय निकुञ्ज र मध्यवर्ती क्षेत्रलाई हस्तान्तरण गरेको थियो । यस समितिले हाल सम्म नेपालका २२६ वटा भन्दा बढि ताल, दह, कुण्ड तथा पोखरीहरुमा संरक्षणका कार्यहरु गरि ६२ वटा जिल्लाका ताल संरक्षण सरोकारवाला, उपभोक्ता समिति तथा संरक्षणकर्ताहरुलाई ताल संरक्षण र प्रवर्द्धन सम्बन्धी नियमित रुपमा तालिम तथा अभिमुखिकरण प्रशिक्षण दिदै आएको छ । तालबाट समुदायको जीविकोपार्जनमा टेवा पुऱ्याउन मत्स्यपालनको लागि पोखराको रुपा तालको पूर्वाधार तयार गर्ने कार्यका लागि हाल सम्म सहयोग गर्दै आएको छ । यसको अलवा राष्ट्रिय ताल संरक्षण विकास समितिले आफ्नो स्थापना दिवसको शुअवसरमा हरेक वर्ष फागुन २३ गतेका दिन राष्ट्रिय ताल दिवसकोरुपमा तालको संरक्षण र प्रवर्द्धन सम्बन्धी विषयगत तथा जनचेतनामुलक अर्न्तक्रिया कार्यक्रमहरु आयोजना गर्दै आइरहेको छ । यस समितिले साधन श्रोत तथा जनशक्तिको सिमित परिधिमा रहेर पनि ताल तथा सिमसार संरक्षणको लागि केहि महत्वपूर्ण कामहरु सम्पन्न गरेको छ ।

नेपालमा प्रथम पटक आयोजित अन्तर्राष्ट्रिय ताल सम्मेलन २०१८ को सन्दर्भ : नेपालको सविधानले प्राकृतिक श्रोत-साधन र सम्पदाहरुको संरक्षण, प्रवर्द्धन र उपयोगको अग्राधिकार स्थानिय निकायलाई दिँदा पनि प्राकृतिक श्रोत-साधन र सम्पदाहरुको संरक्षण र उपयोग उचित तरिकाले हुन सकेको छैन । प्राकृतिक श्रोत-साधन माथीको अतिक्रमण र दोहन कार्यहरु तिब्ररुपमा बढिरहेका छन् । कतिपय स्थानिय निकायहरुले यस कार्यलाई आय-आर्जनको आधार बनाएका छन् । यो अपवित्र कार्यले पारिस्थितिक प्रणाली विथोलिन गई, मानवीय जनजीवन तथा अन्य प्राणी र वनस्पतिमा समेत प्रत्यक्षरुपमा नकमरात्मक प्रभाव पारेको छ । यस्ता गतिविधिहरुबाट नेपालका ताल तथा सिमसार क्षेत्रहरु पनि अछुत्तो रहन सकेका छैनन् । अझ ताल तथा सिमसार क्षेत्रहरुको विनास र क्षयिकरणमा मानवीय कारणका अलवा प्राकृतिक कारणहरु पनि जोडिएर आउँछन् । जलवायू-परिवर्तन देखि बाढी, पहिरो जस्ता प्राकृतिक घटनाहरुले पनि प्रत्यक्ष प्रभाव पार्दछन् । इतिहासको कालखण्डमा सृजना भएका तालहरु कमश : विनास र लोप हुदैछन् भने नयाँ ताल तथा सिमसार क्षेत्रहरुको सृजना हुने प्राकृतिक घटना र प्रकृयाहरु अति दुर्लभ छन् । ताल तथा सिमसारक्षेत्रहरु नियमित जल प्रवाहका आधारशिला हुन् । हिमताल र सिमसार क्षेत्रहरु नदीहरुका जननी हुन् । नेपालका ठूला नदीहरुको मुख्य श्रोत हिमतालहरु नै हुन् ।

हाम्रो मुलुकको सन्दर्भमा तालको स्वामित्व, उपयोग र संरक्षणका विषयहरु नेपाल सरकारका विभिन्न मन्त्रालय र स्थानिय निकायहरु संग सम्बन्धित छन् । तालको स्वामित्वको सवालमा सम्बन्धित निकायहरुका आ-आफ्नै प्रकृतिको दावी भएतापनि संरक्षणको दृष्टिकोणबाट हेर्दा ती निकायहरु त्यति स्पष्टरुपमा जिम्मेवार देखिदैनन्, जसले गर्दा संरक्षणको पाटोले गति लिन सकेको छैन । ताल तलैयाहरुको समुचित संरक्षण, प्रवर्द्धन र उपयोगको उदेश्यले स्थापित राष्ट्रिय ताल संरक्षण विकास समितिसंग पर्याप्त कानूनी अधिकार, साधन श्रोत तथा जनशक्ति नहुँदा सशक्त भूमिका निवार्ह गर्न कठिनता छ । यस वास्तविकतालाई मध्यनजर राख्दै नेपालका तालहरुको दिगो संरक्षण, प्रवर्द्धन र उपयोग लगायतका क्षेत्रमा देखिएका सबै प्रकारका चुनौतिहरुको उजागरण गर्दै मुलुकको बदलिदो परिस्थिति अनुरूप नीति नियमहरुको पुनरावलोकन देखि संरक्षणकर्मी र नागरिकहरुको सचेतना अभिवृद्धि, ताल संरक्षणमा क्रियाशिल अन्तर्राष्ट्रिय संघ संस्था र व्यक्तिहरुसंगको सम्बन्ध विस्तार लगायतका आधारशिलाहरु तयार पार्न आवश्यक छन् । यसका लागि राष्ट्रिय र अन्तर्राष्ट्रिय स्तरका गोष्ठि, सेमिनार, अर्न्तक्रिया र सभासम्मेलन लगायतका विचार मन्थनका विधिहरु सहयोग सिद् हुन्छन् । यिनै विधि र प्रकृयाद्वारा नेपालका तालहरुलाई राष्ट्रिय र अन्तर्राष्ट्रिय जगतमा सुपरिचित गराउँदै पर्यटन प्रवर्द्धनको आयमलाई विस्तार गर्न सकिन्छ भन्ने दृढविश्वासका साथ नेपालमा अन्तर्राष्ट्रिय ताल सम्मेलन आयोजना गर्ने संकल्प सहित समितिले यसको औपचारिक निर्णय २०६३ साल असोज ४ गतेको वृहत सार्वजनिक भेला सहितको अर्न्तक्रिया तथा डुङ्गा र जलयात्राका सामाग्रीहरु हस्तान्तरण कार्यक्रम पश्चात नेपाल सरहद भित्रको सबै भन्दा ठूलो र सुन्दर ताल राजा महेन्द्रले स्वर्गकी अप्सरा उपनामले पुकारेका रारा तालको किनारमा आयोजित समितिको ४०



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औं बैठकले २०७४ साल फागुन २२-२५ गते सम्म काठमाडौंमा अन्तर्राष्ट्रिय ताल सम्मेलन गर्ने निर्णय गर्‍यो । तर विविध कारणले उक्त निर्धारित समयमा सम्मेलन आयोजना गर्न कठिनाई उत्पन्न भई सम्मेलन केहि समयका लागि पछि सार्नु पर्ने परिस्थिति सृजना भयो । तथापि अनुकूल समयमा सम्मेलन आयोजना गर्ने प्रतिवद्धतालाई कायमै राखियो र तदनुसार २०७४ साल फागुन २१ गतेको समितिको ४७ औं बैठकले स्थगित अन्तर्राष्ट्रिय ताल सम्मेलन २०७५ साल वैशाख २८-३० गते सम्म पोखरामा आयोजना गर्ने दोस्रो निर्णय गर्‍यो । काठमाण्डौमा गर्ने भनिएको उक्त सम्मेलनलाई पोखरा लेखनाथ महानगरपालिकाको आग्रह तथा सहभागितालाई समेत मध्यनजर गरेर पोखरामा गर्ने निर्णय गरिएको थियो । सोही बैठकले समितिका अध्यक्षको अध्यक्षतामा विभिन्न प्रतिष्ठित व्यक्ति र संघ संस्थालाई समेटेर अन्तर्राष्ट्रिय ताल सम्मेलन आयोजक मुल समिति समेत गठन गर्नुका साथै सम्मेलनको प्राविधिक संयोजकमा डा. विष्णु भण्डारीज्यूलाई मनोनित गरि सम्मेलनलाई सफलताका साथ सम्पन्न गर्न आवश्यक आन्तरिक र बाह्य व्यवस्थापनका सम्पूर्ण तयारीका लागि समितिका पदाधिकारीज्यूहरु, कर्मचारी वर्गहरु, तथा संयोजक लगायत हामी सबैले सम्मेलनलाई राष्ट्रको प्रतिष्ठाका रुपमा आत्मासाथ गर्दै एक ढिक्का भएर अहोरात्र क्रियाशिल भयौं ।

अन्तर्राष्ट्रिय ताल सम्मेलनको लक्ष्य र उद्देश्य : ताल तथा सिमसार क्षेत्रहरुको वृद्धो विनास, विघटन र प्रदुषण संसारभरि चुनौतिका रुपमा देखिएका छन् । यी परिघटनाहरुबाट दक्षिण एसियाकै जलभण्डारको रुपमा स्थापित नेपालका विशेष गरि हिमाली र पहाडी भू-भागमा अवस्थित ताल तलैया र सिमसार क्षेत्रहरु पनि प्रत्यक्ष प्रभावित छन् । प्राणी र वनस्पति जगतका यी आधारभूत जलसम्पदाहरु, कति प्राकृतिक र कति मानविय कारणले दिनपरिदिन संकट उन्मुख छन् । नेपाल लगायत संसारका सबै मुलुकका ताल र सिमसार क्षेत्रहरु तिब्र गतिमा विनास र लोप हुदै जानु विश्व मानव समुदायकै लागि एउटा ठुलो समस्या हो । यी समस्याहरु हाम्रा साभ्ना समस्या हुन् । हाम्रा यी साभ्ना समस्याहरुको समाधान हाम्रो साभ्ना प्रयास बाट नै सम्भव छ । ताल तलैया तथा सिमसार क्षेत्रहरुको संरक्षण, प्रवर्द्धन र दिगो उपयोगको सन्दर्भमा हरेक मुलुकले आ-आफ्नै प्रकारका निति, नियम तथा अनुभव, युक्ति, ज्ञान, प्रविधि र संयन्त्रको निर्माण गरेका छन् । पृथकरुपमा रहेका यी विविध सूचना, ज्ञान र अनुभवहरु एउटै मञ्चबाट एकअर्कामा सम्प्रेषण र आदानप्रदान गर्ने माहोलको सृजना गरि र नेपालका धार्मिक, सांस्कृतिक र पर्यटकीय महत्त्वका ताललाई विश्वसामु परिचित गराई पर्यटन प्रवर्द्धनका साथै तालको महत्त्व एवम यसको संरक्षणमा स्थानीय समुदायको सहभागिता र जनसमुदायले खेल्नुपर्ने भूमिका वारेमा समेत जनचेतना अभिवृद्धि गराउने लक्ष्य राखि राष्ट्रिय ताल संरक्षण विकास समितिले "दिगो उपयोगिताको लागि ताल तथा सिमसार संरक्षण" को उद्देश्य सहित नेपाल, भारत, जापान, म्यानमार, श्रीलंका र बङ्गलादेश समेत ६ वटा मुलुकहरुको सहभागीतामा नेपालमा प्रथम पटक अन्तर्राष्ट्रिय ताल सम्मेलन आयोजना गरि सफलताका साथ सम्पन्न गरेको छ ।

नेपाल लगायत अन्य मुलुकहरुका ताल तथा सिमसार क्षेत्रहरुको अवस्था र संरक्षणमा देखिएका चुनौतिहरुको वारेमा सम्मेलनका प्रमुख वक्ताहरु, नेपालका डा.महेश्वर ढकाल, प्रा.डा. तेजकुमार श्रेष्ठ र डा. विष्णु भण्डारी त्यसैतै जापानका प्रा. डा. मासाहिसा नाकामुरा र भारतका डा. अजित पटनायक लगायतका संरक्षण विज्ञहरुद्वारा व्यक्त गरिएका गहन विचारहरुका साथै ताल संरक्षणका राष्ट्रिय तथा अन्तर्राष्ट्रिय विद्वान व्यक्तित्वहरुबाट प्रस्तुत भएका विभिन्न विधाका कार्यपत्रहरुको निष्कर्ष तथा सम्मेलनमा सहभागी संरक्षणकर्मीहरु, प्राध्यापक, विशेषज्ञ, सोधकर्ता, शिक्षक, विद्यार्थी, पर्यटन व्यवसायीहरु, पत्रकार तथा सामाजिक अभियन्ता लगायतका जनसमुदायहरुको राय- सुझावहरुको निष्कर्ष र सम्मेलनद्वारा जारी गरिएको घोषणा-पत्र समेत संलग्न गरि यो दस्तावेज प्रकाशित गर्न पाउँदा हामी अत्यन्तै हर्षित छौं र यो दस्तावेज ताल तथा सिमसार क्षेत्रको संरक्षणको सन्दर्भमा निकै उपयोगी र कोसेढङ्गा सावित हुने विश्वास समेत लिएका छौं ।

विशेष धन्यवाद : २०७५ साल वैशाख २८-३० गतेसम्म गण्डकी प्रदेशको राजधानी पोखरामा आयोजित अन्तर्राष्ट्रिय ताल सम्मेलन उद्घाटन सत्रका प्रमुख अतिथि राष्ट्रिय सभाका अध्यक्ष सम्माननीय श्री गणेश प्रसाद



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च.नं. :-

तिमिलिसिनाज्यू र सोहि सम्मेलनका समापन सत्रका प्रमुख अतिथि गण्डकी प्रदेशका माननीय मुख्य मन्त्री श्री पृथ्वी सुब्बा गुरुङ्गज्यू, त्यसै गरि अतिथिज्यूहरु: नेकपा एमाले केन्द्रीय कमिटिका सदस्य तथा पर्यटन प्रवर्द्धन विभाग प्रमुख, श्री सूर्य थापाज्यू, गण्डकी प्रदेशका उद्योग, पर्यटन, वन तथा वातावरण मन्त्री माननीय श्री विकास लम्सालज्यू, पूर्व मन्त्री श्री कृपासुर शेर्पाज्यू, पूर्व मन्त्री श्री गणेश शाहज्यू, गण्डकी प्रदेश सभा सदस्य माननीय राजिव पाहारीज्यू, कास्की जिल्ला समन्वय समिति प्रमुख श्री वैन बहादुर अधिकारी क्षेत्रीज्यू, पोखरा लेखनाथ महानगरपालिकाका मेयर श्री मान बहादुर जि.सी.ज्यू, राष्ट्रिय ताल संरक्षण विकास समितिका कार्यकारी निर्देशक श्री लंक बहादुर शाहीज्यू, त्यसै गरि समितिका सदस्यज्यूहरु श्री मिडमा कामी शेर्पाज्यू, श्री लक्ष्मी कार्कीज्यू, श्री प्रदिप आचार्यज्यू, नेपाल पर्यटन बोर्डका प्रमुख कार्यकारी अधिकृत श्री दिपक राज जोशीज्यू, संस्कृति, पर्यटन तथा नागरिक उड्डयन मन्त्रालयका प्रतिनिधि श्री राजेश गौतमज्यू, वन मन्त्रालयका प्रतिनिधि श्री धनन्जय लामिछानेज्यू र सिँचाई मन्त्रालयका प्रतिनिधि श्री कृष्ण प्रसाद उपाध्यायज्यू, पूर्व अध्यक्षज्यूहरु, अन्तर्राष्ट्रिय ताल सम्मेलनका प्राविधिक संयोजक तथा यस दस्तावेज निर्माणका सल्लाहकार डा. विष्णु भण्डारीज्यू, सह सचिव, डा. महेश्वर ढकालज्यू, प्रा.डा. तेज कुमार श्रेष्ठज्यू, डा. पुष्पलाल पोखरेलज्यू, श्री शैलेन्द्र पोखरेलज्यू र विभिन्न सरकारी तथा गैरसरकारी संघ संस्थाबाट पाल्नुहुने प्रतिनिधिज्यूहरु, पर्यटन व्यवसायीज्यूहरु, ताल संरक्षण अभियन्ताज्यूहरु, ताल उपभोक्ता समितिका प्रतिनिधिज्यूहरु तथा कार्यपत्र प्रस्तुत गर्ने विद्वानवर्गहरु, विभिन्न निकायका सुरक्षाकर्मीज्यूहरु, समितिका कर्मचारीमित्रहरु श्री प्रभा पाण्डे, श्री प्रकाश श्रेष्ठ, श्री पेम्वा फुट्टी शेर्पा, श्री राज कुमार महजन, श्री सरस्वती थापा, जनमैत्री बहुमुखी क्याम्पस, पृथ्वी नारायण क्याम्पस, पोखरा वन विज्ञान अध्ययन संस्थान लगायतका सहभागी विद्यार्थीवर्गहरु, प्रकृति संरक्षणकर्मीज्यूहरु, सामाजिक अभियान्ताज्यूहरु र पत्रकारवर्ग लगायत सम्पूर्ण सहभागी मान्यजनहरु प्रति राष्ट्रिय ताल संरक्षण विकास समितिको तर्फबाट म हार्दिक धन्यवाद व्यक्त गर्दछु । त्यसै गरी यस सम्मेलनलाई आर्थिक सहयोग उपलब्ध गराउने संस्कृति, पर्यटन तथा नागरिक उड्डयन मन्त्रालय, नेपाल पर्यटन बोर्ड, USAID PAANI PROGRAM, नेपाल पर्वतारोहण संघ, विश्व वन्यजन्तु कोष (हरियो वन कार्यक्रम), International Lake Environment Committee Foundation(ILEC), ICIMOD र रुपाताल पुर्नस्थापना तथा मत्स्यपालन सहकारी संस्था लगायत सम्पूर्ण सरकारी तथा गैरसरकारी सहयोगी संघ संस्थाहरु प्रति म विशेष आभार तथा शुभकामना व्यक्त गर्दछु ।

धन्यवाद ।

मानिकजी थापा

अध्यक्ष
अध्यक्ष



संस्कृति, पर्यटन तथा नागरिक उड्डयन मन्त्रालय
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च.नं. :-

आभार

ताल तथा सिमसारलाई मानवीय सभ्यताको सर्वाङ्गीण विकासबाट पृथक राख्न सकिन्न भन्ने वास्तविकतालाई मध्यनजर राख्दै नेपाल सरकारबाट नेपालका सम्पूर्ण ताल, तलैया, दह, कुण्ड, पोखरी एवं सिमसारहरूको संरक्षण, सम्बर्द्धन तथा उक्त क्षेत्रहरूको जैविक विविधता, वातावरण र सुन्दरताको संरक्षण तथा विकास गर्नका लागि विकास समिति ऐन २०१३ अन्तर्गत २०६३ फागुन २३ गते संस्कृति, पर्यटन तथा नागरिक उड्डयन मन्त्रालयको मातहतमा रहने गरी राष्ट्रिय ताल संरक्षण विकास समितिको गठन गरिएको हो ।

स्थापना काल देखि नै नेपाल भरीका ताल, तलैया, दह, कुण्ड, पोखरी एवं सिमसार क्षेत्रहरूको महत्व, उपयोगिता र प्रयोगको बारेमा राष्ट्रिय तथा अन्तर्राष्ट्रिय स्तरमा सूचनाको आदान प्रदान गरी धार्मिक, सांस्कृतिक, पर्यटकीय तथा प्राकृतिक महत्वका तालहरूको संरक्षण, विकास तथा संवर्द्धनमा ताल क्षेत्रका स्थानीय समुदायहरूलाई समेत सहभागी गराई समितिले विभिन्न कार्यक्रमहरू संचालन गर्दै आईरहेको छ । यसै परिप्रेक्ष्यमा "दिगो उपयोगिताको लागि ताल तथा सिमसार संरक्षण" भन्ने मूल उद्देश्य राखी यस समितिको आयोजनामा नेपालमा पहिलो पटक "अन्तर्राष्ट्रिय ताल सम्मेलन २०१८" सम्पन्न भएको छ । तालैतालको सुन्दर नगरी पोखरामा भव्यताका साथ सम्मेलन सम्पन्न भएकोमा म ज्यादै हर्षित छु । यस सम्मेलनको उद्घाटन र समापन समारोहका प्रमुख अतिथीज्यूहरू तथा अन्य अतिथीज्यूहरूले राख्नु भएका विचारहरूका साथसाथै राष्ट्रिय तथा अन्तर्राष्ट्रिय विज्ञहरूद्वारा प्रस्तुत गर्नु भएका कार्यपत्रहरूबाट प्राप्त भएका निष्कर्ष एवं पोखरा घोषणा-पत्रले तालतलैया र सिमसार क्षेत्रहरूको संरक्षण, प्रवर्द्धन र दिगो उपयोगका लागि मार्ग निर्देशक ग्रन्थको रूपमा उपयोग हुनेमा म विश्वस्त छु । यस सम्मेलनलाई भव्य र सभ्य रूपमा सम्पन्न गर्नको लागि सहयोग पुऱ्याउने सम्पूर्ण महानुभावहरूलाई राष्ट्रिय ताल संरक्षण विकास समितिको तर्फबाट म हृदय देखि धन्यवाद दिन चाहान्छु ।

राष्ट्रिय ताल संरक्षण विकास समितिको निमन्त्रणालाई स्वीकार गरेर आफ्नो अमूल्य समय दिनुभई आफ्नो गरिमामय उपस्थिति सहित हामीलाई हौसला प्रदान गर्नु भएकोमा "अन्तर्राष्ट्रिय ताल सम्मेलन २०१८" का उद्घाटन समारोहका प्रमुख अतिथि, राष्ट्रिय सभाका सम्माननीय अध्यक्ष श्री गणेश प्रसाद तिमिल्सिनाज्यू, समापन समारोहका प्रमुख अतिथि, गण्डकी प्रदेशका माननीय मुख्य मन्त्री श्री पृथ्वी सुब्बा गुरुङ्गज्यू प्रति विशेष आभार व्यक्त गर्दछु । साथै नेकपा एमाले पर्यटन प्रवर्द्धन विभागका प्रमुख श्री सूर्य थापाज्यू, गण्डकी प्रदेशका माननीय उद्योग, पर्यटन, वन तथा वातावरण मन्त्री श्री विकास लम्सालज्यू, संस्कृति, पर्यटन तथा नागरिक उड्डयन मन्त्रालयका पूर्व मन्त्री श्री कृपासुर शोर्पाज्यू, विज्ञान तथा वातावरण मन्त्रालयका पूर्व मन्त्री श्री गणेश शाहज्यू, गण्डकी प्रदेश सभा सदस्य माननीय राजिव पाहारीज्यू, जिल्ला समन्वय समिति कास्कीका प्रमुख श्री बैन बहादुर अधिकारी क्षेत्रीज्यू, वन तथा वातावरण मन्त्रालयका सह सचिव डा. महेश्वर ढकालज्यू, पोखरा लेखनाथ महानगरपालिकाका मेयर श्री मान बहादुर जि.सी.ज्यू, प्रा.डा. तेज कुमार श्रेष्ठज्यू, उद्योग, पर्यटन, वन तथा वातावरण मन्त्रालय प्रदेश नं. ४ का सचिव डा. बुद्धिसागर पौडेलज्यू, नेपाल पर्वतारोहण संघका सचिव श्री टिका राम गुरुङ्गज्यू, पोखरा लेखनाथ उपत्यका नगर विकास समितिका अध्यक्ष श्री सुन्दर श्रेष्ठज्यू, उद्योग वाणिज्य संघ प्रदेश नं. ४ का अध्यक्ष श्री सन्जीव कोईरालाज्यू, प्रा.डा. देवेन्द्र बहादुर लामिछानेज्यू, जिल्ला विकास समितिका पूर्व सभापति श्री पुण्य पौडेलज्यू, राष्ट्रिय ताल संरक्षण विकास समितिका पूर्व अध्यक्षज्यूहरू, श्री भलक पाणी तिबारीज्यू, श्री शालीक राम पौडेलज्यू, पोखरा उपत्यका नगर विकास समितिका पूर्व अध्यक्ष श्री विश्व प्रकाश लामिछानेज्यू, विभिन्न पार्टीका तर्फबाट प्रतिनिधित्व गर्ने प्रतिनिधिज्यूहरू, पोखरा लेखनाथ महानगरपालिकाका वडा अध्यक्षज्यूहरू, ताल संरक्षण अभियन्ताज्यूहरू, ताल उपभोक्ता समितिका प्रतिनिधिज्यूहरू, विभिन्न सरकारी तथा गैरसरकारी संघ संस्थाबाट पाल्नुहुने प्रमुख तथा प्रतिनिधिज्यूहरू, पोखरा पर्यटन परिषद, पर्यटन व्यवसायीज्यूहरू, वातावरण संरक्षणकर्मीज्यूहरू, पोखरा वन विज्ञान अध्ययन संस्थान, पृथ्वी नारायण क्याम्पस, जनमैत्री बहुमुखी



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च.नं. :-

क्याम्पस, पोखरा तथा पत्रकार मित्रहरु, सुरक्षाकर्मीहरु र विद्यार्थीहरु लगायत सबैमा राष्ट्रिय ताल संरक्षण विकास समितिको तर्फबाट म हार्दिक आभार प्रकट गर्दछु ।

यसै गरी विभिन्न देशहरुबाट पाल्नुभएका विदेशी प्रस्तुतकर्ताहरु Prof. Dr. Masahisa Nakamura, Japan, Dr. Ajit Kumar Pattnaik, India, Dr. Indika Rohan Palihakkara, Srilanka, Dr. Sanowar Hossain, Bangladesh, Mr. Abdulah Al Nayeem, Bangladesh, Mr. Tapas Ranjan Chakraborty, Bangladesh, Mrs. Thiri Dae We Aung, Myanmar तथा नेपालका तर्फबाट कार्यपत्र प्रस्तुतकर्ताहरु प्रा.डा. तेज कुमार श्रेष्ठज्यू, डा. महेश्वर ढकालज्यू, श्री जगननाथ अधिकारीज्यू, श्री मेघ आलेज्यू, श्री शैलेन्द्र पोखरेलज्यू, श्री समज्वल रत्न वज्रचार्यज्यू, डा. विष्णु भण्डारीज्यू, डा. पुष्पलाल पोखरेलज्यू, डा. रमेश राज पन्तज्यू, श्री वसन्त राज लामिछानेज्यू, श्री ऋषि राम त्रिपाठीज्यू, श्री भानु पराजुलीज्यू, श्री पूर्ण बहादुर कुंवरज्यू र प्रा.डा. देवेन्द्र बहादुर लामिछानेज्यूलाई धन्यवाद व्यक्त गर्दछु ।

त्यसैगरी सम्मेलनलाई महत्वपूर्ण सहयोग पुऱ्याउनुहुने सरकारी तथा गैरसरकारी निकायहरु, पोखरा लेखनाथ महानगरपालिका, विश्व वन्यजन्तु कोष (WWF), USAID PAANI PROGRAM, नेपाल पर्वतारोहण संघ (NMA), The International Centre for Integrated Mountain Development (ICIMOD) र नेपाल पर्यटन बोर्ड (NTB) प्रति हार्दिक धन्यवाद व्यक्त गर्दछु । यस सम्मेलनलाई सफल बनाउने कार्यमा प्रारम्भ देखिनै महत्वपूर्ण योगदान पुऱ्याउदै आउनु भएका सल्लाहाकार तथा प्राविधिक समितिका संयोजक डा. विष्णु भण्डारीज्यू र डा. पुष्पलाल पोखरेलज्यू प्रति हार्दिक आभार प्रकट गर्न चाहान्छु ।

यस सम्मेलनलाई सफल पार्न अहोरात्र खटिरहनु भएका यस राष्ट्रिय ताल संरक्षण विकास समितिका सदस्यज्यूहरु श्री मिडमा कामी शेर्पाज्यू, श्री लक्ष्मी कार्कीज्यू, श्री प्रदिप आचार्यज्यू, नेपाल पर्यटन बोर्डका प्रमुख कार्यकारी अधिकृत श्री दिपक राज जोशीज्यू, संस्कृति, पर्यटन तथा नागरिक उड्डयन मन्त्रालयका प्रतिनिधी श्री राजेश गौतमज्यू, वन मन्त्रालयका प्रतिनिधी श्री धनन्जय लामिछानेज्यू र सिँचाई मन्त्रालयका प्रतिनिधी श्री कृष्ण प्रसाद उपाध्यायज्यू तथा यस समितिमा कार्यरत कर्मचारीहरु श्री प्रभा पाण्डे, श्री प्रकाश श्रेष्ठ, श्री पेम्बा फुट्टी शेर्पा, श्री राज कुमार महर्जन, श्री सरस्वती थापा साथै माउण्ट कैलास रिसोर्ट परिवार लगायत सम्पूर्ण व्यक्ति, संघसंस्थाहरु प्रति हार्दिक धन्यवाद व्यक्त गर्दछु ।

अन्तमा यस “अन्तर्राष्ट्रिय ताल सम्मेलन २०१८”ले विद्यमान परिस्थितीमा रहेका ताल तथा सिमसार क्षेत्रहरुका समस्या र चुनौतीहरुलाई उजागर गर्दै भविष्यमा उक्त क्षेत्रहरुमा स्वच्छ वातावरण सृजना भई दिगो उपयोग गर्नका लागि अत्यन्तै फलदायी हुनेछ भन्ने मैले पूर्ण विश्वास लिएको छु । जय ताल संरक्षण !

लंक बहादुर शाही
कार्यकारी निर्देशक

कार्यकारी निर्देशक

पोखरा घोषणा पत्र

अन्तर्राष्ट्रिय ताल सम्मेलन, नेपालको गण्डकी प्रदेश, पोखरामा मे ११ देखि १३ सम्म आयोजना गरिएको थियो । उक्त सम्मेलन राष्ट्रिय ताल संरक्षण विकास समिति, संस्कृति पर्यटन र नागरिक उड्डयन मन्त्रालयले सयुक्त रुपमा आयोजना गरिएको थियो ।

सो सम्मेलनलाई सफल पार्न अमेरिकी सहयोग नियोग अन्तर्गतको जलीय प्राकृतिक श्रोत सुधार कार्यक्रम (पानी कार्यक्रम), विश्व वन्यजन्तु कोषको हरियो बन कार्यक्रम, नेपाल पर्यटन बोर्ड, पोखरा लेखनाथ महानगरपालिका, रुपा ताल पूर्णस्थापना तथा मत्स्य सहकारी संस्था, ICIMOD, नेपाल पर्वतारोहण संघ र ILEC जापानले आर्थिक तथा प्राविधिक सहयोग गरेका थिए । उक्त सम्मेलनमा बंगलादेश, भारत, जापान, म्यानमार, श्रीलंका र आयोजक देश नेपाल सहित ६ वटा देशका २३७ जना सहभागीहरूको उपस्थितिमा सम्पन्न भएको थियो । सहभागीहरूले तालको पारिस्थितिक प्रणालीको पर्यावरणीय कार्य, सेवा र लाभको महत्वमाथि प्रकाश पार्नुका साथै स्वस्थ वातावरण कायम गर्नका लागि सम्पूर्ण संरक्षणका प्रयासहरूको सराहना गरेका थिए, जसका लागि निम्न विषयहरूलाई ध्यान दिनु पर्ने देखिन्छ ।

१. तालतलैया स्रोतहरूको व्यवस्थापन एक समग्र पद्धतिमा आधारित भएर गरिनुपर्छ, जसले स्थानिय पारिस्थितिक प्रणालीलाई खलल् नपुग्ने गरि समुदायलाई दिगो जीविकोपार्जनका अवसरहरू (जस्तै पर्यापर्यटन) उपलब्ध गराउन अभिप्रेरित गर्नुपर्दछ ।
२. जलवायु परिवर्तन तथा प्राकृतिक विपद न्यूनिकरणका लागि तालतलैयाहरू विश्वव्यापी रुपमा अपरिहार्य छन् ।
३. स्थानिय समुदायले दिगो जीविकोपार्जनका लागि मिचाहा प्रजातिहरू जस्तै जलकुम्भीलाई श्रोतको रुपमा उपयोग गर्न अभिप्रेरित गरिनुपर्दछ ।
४. ताल बेशीन व्यवस्थापन तथा संरक्षणका लागि तालको सांस्कृतिक तथा स्थानिय वातावरणीय महत्वलाई एकीकृत व्यवस्थापन गरिनुपर्दछ ।
५. स्थानिय ज्ञान तथा सिपहरूको मूल्याङ्कन गरि राष्ट्रिय नीति निर्माणमा समाहित गरिनुपर्दछ ।

उक्त आवश्यकतालाई मध्यनजर गर्दै तालतलैयाहरूको घट्दो तथा बिग्रदो अवस्थालाई रोकथाम गर्न, बिग्रन नदिन तथा साबिककै अवस्थामा फर्काउन यस अन्तर्राष्ट्रिय ताल सम्मेलनले निम्न कुरामा जोड दिएको छ ।

१. ताल तथा यसका श्रोतहरूको दिगो व्यवस्थापन तथा उपयोगका लागि राष्ट्रिय ताल संरक्षण विकास समितिको सहकार्यमा एकीकृत ताल बेशीन व्यवस्थापनलाई कार्यान्वयन गरिनुपर्दछ ।
२. ताल तथा यसका श्रोतहरूको समुचित उपयोग गर्दै प्रत्येक प्रदेशहरूमा नमूना ताल विकास आयोजनाहरू संचालन गरिनुपर्दछ ।
३. राष्ट्रिय रुपमै सहकार्य पद्धतिलाई सुदृढीकरण गर्न सरकारी, गैर सरकारी तथा समुदायमा आधारित संस्थाहरूको सबलता तथा क्षमताहरूलाई एकीकृत गर्दै ताल तथा यस्को श्रोतहरूको व्यवस्थापनमा सुधार गरिनुपर्दछ ।
४. तालतलैयाहरूको जोखिम मापन तथा बिस्तृत अभिलेखिकरणमा आधारित भएर सबै पारिस्थिक क्षेत्रहरूमा ताल विपेश परियोजना लागू गर्नुपर्दछ ।
५. युवा अनुसन्धान तथा स्रोतकर्ताहरूलाई प्रेरित गरि कार्यगत अनुसन्धान गर्नका लागि विपेश कोषको स्थापना गरिनु पर्दछ ।
६. यस सम्मेलनमा आएका सहभागीहरूले राष्ट्रिय ताल संरक्षण विकास समितिलाई निम्न कुराहरूको सिफारिस गर्नुभयो ।
 - क. राष्ट्रिय ताल संरक्षण विकास समितिले तयार पारेको ताल विकास रणनीतिक योजनाको कार्यान्वयन गर्न ।
 - ख. एकीकृत ताल बेशीन व्यवस्थापनमा आधारित रहेर दक्षिण एशियाली तर्दथ समिति गठन गर्न ।
७. यस सम्मेलनका सहभागीहरूले राष्ट्रिय ताल संरक्षण विकास समिति र पोखरा लेखनाथ महानगरपालिकालाई सम्मेलन पोखरामा आयोजना गरेकोमा प्रशंसा तथा सम्मान व्यक्त गर्नु भएको थियो ।
८. यस सम्मेलनले आयोजक र सहभागीहरूलाई अन्तर्राष्ट्रिय ताल सम्मेलनका प्रकाशनहरूलाई नेपालको संघीय सरकार, प्रदेश सरकार, स्थानिय सरकार, शैक्षिक संस्थाहरू र अन्य उपयुक्त सभा, सम्मेलन तथा कार्यशालाहरूमा प्रवर्द्धन तथा प्रचारप्रसार गर्न आग्रह गर्दछ ।

Pokhara Declaration

The International Lake Conference was held at Pokhara, Gandaki Pradesh, Nepal from 11 to 12 May 2018. The Conference was organized by the National Lake Conservation Development Committee (NLCDC) of the Ministry of Culture, Tourism and Civil Aviation and supported by USAID PAANI Program, WWF Hariyo Ban Program, Nepal Tourism Board, Pokhara Lekhnath Metropolitan City, Rupa Lake Restoration and Fisheries Cooperative, ICIMOD, Nepal Mountaineering Association and ILEC. The Conference was attended by 237 participants from 6 countries; Bangladesh, India, Japan, Myanmar, Sri Lanka and the host country, Nepal.

The participants recognized the importance of lake ecosystems and their ecological functions, services and benefits. They also appreciated the conservation efforts undertaken for the maintenance of a healthy environment and suggested to take into considerations

1. That management of lake resources must be pursued in a holistic approach for creating the sustainable livelihood opportunities (such as ecotourism) to local communities without hampering the integrity of the local ecosystem;
2. That mitigation measures against natural disasters and climate change surrounding the lake are becoming imminent globally;
3. That people need to manage invasive species such as Water Hyacinth and if possible be encouraged to sustainably utilize them as resources for their sustainable use.
4. That the cultural values of lakes and their surrounding environments must be integrated as part of lake basin management and conservation; and,
5. That the indigenous knowledge collected from the Nepalese people should be evaluated and integrated into national policy formulations.

In order to "**stop, prevent and reverse the trend of loss and degradation of lake resources**" in Nepal, the Conference recognizes the need for:

1. Implementation of the Integrated Lake Basin Management (ILBM) in collaboration with International Lake Environment Committee Foundation (ILEC, Japan) for sustainable management and wise use of lakes and their resources;
2. Development of model projects in each province for the wise use of lakes and their resources;
3. Strengthening of national cooperation mechanism for connecting governments, I/NGOs, CBOs and communities and combine their strengths and competencies for the improved management of lakes and their resources;
4. Implementation of a special project to prepare the vulnerability and a comprehensive inventory of lakes representing all ecological zones; and,
5. Establishment of special grant schemes to assist youth researchers for action-oriented research.
6. Finally, the participants recommend the NLCDC to:
 - a. Implement the National Lake Conservation and Development Strategy Plan; and
 - b. Set up an Ad Hoc Committee for the establishment of the ILBM South Asian Platform.
7. The participants highly commended the National Lake Conservation Development Committee (NLCDC) and Pokhara Lekhnath Metropolitan City for hosting the Conference.
8. The Conference requests the organizer and participants to disseminate and promote the results of this Conference to the Federal Government of Nepal, Provincial Governments and Local governments, academia, partners and other appropriate fora and mechanisms.

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Inaugural Session

The inaugural session began with welcome remarks from the Executive Director of NLCDC, Mr. Lanka Bahadur Shahi. Mr. Shahi on behalf of the Organizing Committee offered his cordial welcome to all the dignitaries, experts and participants to the Conference. While explaining the reasons to have chosen the site of Pokhara as a venue for the conference, he said that the international conference was being held for the first time in Nepal and he would leave no stone unturned to offer hospitality to the participants. According to him, the primary objective of the Conference is to provide a forum for the participants for the exchange and sharing of knowledge, experiences, information and successful cases on sustainable management and conservation of lakes and lake resources in the South-east region. He highlighted the importance of the lakes and wetlands to combat the growing threat coming from climate change and global warming. He hoped that the Conference would prove useful and productive, not only for mutual learning but also establishing a base for sharing our concerns, challenges and creativity related to best practices, management and conservation of lake resources in the region. He also put forward the proposal for establishing an Integrated Lake Basin Management Platform in the SAARC region.

Following the welcome speech, the conference was formally inaugurated by Right Honorable Mr. Ganesh Prasad Timilsina, Chairman of the National Assembly by lightning the traditional *Panus* and then by national anthem. The Chief Guest, Right Honorable Ganesh Prasad Timilsina while delivering his inaugural speech, said the lake and lake resources play a vital role in making Nepal a prosperous country. They are our frontiers for sustainable development. His speech titled *Udghatan Mantabya* (Inaugural Speech) in Nepali appears as first *Mantabya* (Remarks) of the proceedings. Then other speakers began their deliberations, which are briefly summarized below.

1. Mr. Surya Thapa, Tourism Promotion Expert gave a good example of a close link between lakes, wetlands and tourism so as to alleviate poverty from the country. Therefore, lakes and wetlands are the

important natural resources that should be managed and used sustainably. He told that the NLCDC was supposed to organize this Conference in Rara Tal but somehow did not happen. Any way, he was glad to see the conference being held in the beautiful city of Pokhara and participate along with other fellow participants. He was eager to learn best examples and successful practices not only from Nepal but also from the South-East region, for which the Conference is both the opportunity and appropriate place for all of us. He expressed the concern about the National Lake Strategy Plan prepared by the NLCDC, not being implemented even now and suggested its implementation as quickly as possible. This is the key to a "*Prosperous Nepal and Happy Nepali*". He congratulated the NLCDC team for organizing the Conference in Pokhara and hoped that the deliberation would come out to be more relevant and practical. Also, he hoped that this Conference would be successful to thrash out the problems and challenges relating to lake conservation and management in Nepal.

2. Honorable Minister, Mr. Bikash Lamsal shed light on the importance of the indigenous knowledge for lake conservation. He also said that each lake and wetland is equally important - ecologically, economically and even culturally. According to the minister, each and every threat and issue that affect globally as well as locally should be addressed thoughtfully. He also assured the participants of the Provincial Government's high priority to lakes and wetlands in the Gandaki Pradesh for the promotion of tourism and enhancing local livelihoods.
3. Mr. Ganesh Shah, Ex-Minister of Science and Environment began his deliberation by emphasizing that every drop of water is critically important and should be utilized in Nepal. He said that our lakes are not only the important source of water but also sacred and they contain holy water and therefore a way of earning eternal merit for Hindus and Buddhists alike. History and religious scripts have authenticated

that human civilization began from lakes, rivers, kundas and wetlands. That is why lakes and wetlands should be at the center of our development program, policy and plans. Many of our lakes and wetland are at the brink of extinction and he said that efforts should be put on the ground to rescue them before it is too late.

4. Mr. Kripasur Sherpa, also the Ex-Minister of Culture, Tourism and Civil Aviation took the floor and said that we and the future generation need lakes and wetlands. Therefore, experts, conservationists and scientists should honestly be engaged in their conservation and management. He also underlined the need for the active and responsible involvement of local community and stakeholders at all stage of planning, implementation and beyond. Meaningful participation and mission-oriented involvement is the key to success and therefore it has no option.
5. Prof. Dr. Masahisa Nakamura, Vice-President of the International Lake Environment Conservation Committee (ILEC) Foundation delivered his keynote speech on the Integrated Lake Basin Management (ILBM) approach for the sustainable management and conservation of lakes and lake resources. According to Prof. Nakamura, the ILEC is interested in mainstreaming the ILBM approach in

South-east Asia including Nepal. He wished to support this cause and see the sustainable management and wise use of lakes and lake resources under the umbrella of the ILBM approach. But he also alerted us that there are many challenges and obstacle on the path to its application on the ground.

6. Mr. Tika Gurung, the Secretary of the Nepal Mountaineering Association, opined that Nepal is dotted with lakes, ponds and wetlands, right from the Mount Everest area to the lowest point in the country. He hoped that the Himalayan lakes in Nepal would prove useful to mitigating disasters and outburst flood caused by the breaching of glacial lake. He wished the success of the Conference and hoped that the deliberations would come out with some pragmatic action plans for the promotion of lake tourism in Nepal.

In closing the inaugural session, the Chairperson, Mr. Nani Kaji Thapa, President of the NLCDC offering his heart-felt thanks to the dignitaries and distinguished participants, said that lakes are the basic infrastructures for humans, fauna and flora on the Earth and water is the lifeline for all of them. Therefore, the conservation and wise use of water should be priority number one in Nepal's development agenda. Moreover, he expressed the importance of the lakes and wetlands in his Foreword titled *Prakkathan* in Nepali.

Chapter 1:

Keynotes

Wetlands Management in Nepal: Challenges and Opportunities

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Introduction

Nepal is a landlocked country having mountainous landscape, but rich in wetlands resources. The geographical feature of the country and its beauty is mixed up with Terai, Mountains and Himalayas. In the world map, Nepal is ranked in the 50th position by population and the 93rd by area. Nepalese people are known as honest, religious and responsible citizens in the world. More than that, Nepal is the country of diverse languages and cultures. As Himalaya is the source of cryosphere and glaciers, Nepal has a high potential of hydropower, irrigation and drinking water. The river systems are wetlands having rich biodiversity values. The wetlands are from small to large pools, ponds, dams, and rivers and have been playing a big role in supporting the life of fauna and flora, microorganisms, and their ecosystems. These lakes and rivers are not only important for human civilization but also an attractive destination for domestic and foreign tourists in this modern era. This article highlights the overall status, challenges and opportunities of wetlands in Nepal.

Wetlands in Nepal

Nepal is rich in rivers and lakes. Around 5.5% of the country's total area is covered by the

wetlands. As stated earlier, the Himalayan region is the perennial source of water, almost all the rivers flow from north to south. The rivers which are flown from Himalayas via mountains to the Terai flow in high speed and have high potentials for irrigation, drinking water, hydropower and tourism. The banks of the river, high mountainous peaks, hills and gorges are considered as adventurous tourism places. In Nepal, glaciers, snowflakes, shells, lake floats, wells, ponds and water-related fields are wetlands. Out of these, 48.2% of wetland is covered by rivers, water supply area by 48.6% and remaining 3.2% by lakes, ponds and wells. In recent days, wetlands have not received any priority attention on its conservation, management and sustainable use due to lack of policy priority, public awareness, research, fund and academic interests.

Importance of Wetlands

Wetlands are considered important not only from an ecological and biodiversity conservation perspective, but also from economic, physical, cultural and health aspects. Due to its important role of absorbing polluted and waste substances and cleaning the water on the earth's surface wetland areas are also called the kidney of the Earth. Wetland area is the common place for

fauna, flora and other biological resources. In biodiversity perspective wetland is considered to be the richest and most sensitive area. Wetlands conservation is the main obligation of human race. Looking back at the history, human civilization and culture around wetland is considered the place of creation. Comparatively the lifestyle of marginalized tribes and local communities living around the wetland area is clean, healthy and prosperous. There is also a tradition of worshipping some wetlands as God's dwelling place. The development of cities and urban areas has been possible due to the production of wetland products. Because of these reasons the constitution of Nepal (2072) have given importance to the protection, conservation and management of the wetland areas.

The Ramsar site is the center of attraction for all peoples from children to elderly across the world. Not only that, adventurous sports such as skydiving, hot air balloon, para-gliding, bungee jump, mountaineering biking, mountain marathon, canoeing, micro-flight are the best activities for tourists. Pokhara's Fewa Tal can be considered as a good example. It has been the must visit place in Nepal for every tourist. Tourists take pleasure engaging in activities in and around the wetlands such as bird watching, swimming, boating, photography, fishing, and hiking. Similarly, wetland areas are also considered as important area for religious tourism. The Barahi Temple in the middle of Fewa Tal, the Chatara in the bank of the Koshi river, Triveni, Ghodaghodi Tal, Muktinath, Gosaikunda, Gangasagar of Janakpur are exemplary places not only from ecological, economic and social point of view but also from religious tourism. Similarly rafting in the Kali Gandaki, Trisuli, Koshi and Karnali River as well as boating in Rara Tal are a few popular activities done in Nepal.

Ramsar Convention and Nepal

Ramsar Convention came into effect in 1971. The name came after the Ramsar City of Iran. Nepal has been working together with the Convention as a Contracting Party since 1988. As of 2018, 170 member countries are associated with the Ramsar Convention. Similarly, 2335 Ramsar sites are listed under Ramsar Information Sheet

(RIS) that covers around 249 million ha across the globe. In Nepal, 10 Ramsar have been listed under RIS, the Koshi Tappu Wildlife Reserve is the first Ramsar site (1988) while the Lake Cluster of Pokhara Valley (2016) is the latest and the 10th Ramsar site of Nepal.

Challenges in Wetlands Management

Wetlands are facing various challenges across the country though the degree and extent of challenges vary from one wetland to another. The encroachment of wetland area due to migration and urbanization with growing population can be seen in Fewa Tal of Pokhara and the banks of the Bagmati River in the Kathmandu Valley. Our traditional practice of planting trees and construction of ponds nearby is in the state of extinction. The haphazard constructions of roads in hilly area by the rural municipalities and municipalities without any proper engineering studies are triggering landslide and soil erosion, especially during monsoon. Such landslides and soil erosion cause many damages to the local ponds and lakes and also to human toll and properties. Wetlands are common fields having cross-cutting relation with other systems and sectors. Wetlands not only affect the climate change but also control the rate of ongoing climate change. Everyone says that wetlands are important but they turn their face back at the time of wetland conservation and management. The Federal government has given responsibility to provincial government to conserve wetland, so that the conservation of wetlands can be hopefully carried out in a systematic way. Nepalese people will face more severe situation of water scarcity in the future if the local lakes, ponds and rivers are not conserved with high priority. One study shows that the wetlands have the potential of preserving the double amount of carbon than the forest area does. It is estimated that the peatland in the Himalayas of Nepal has preserved sufficient carbon, but detail study needs to be done. Similarly, the wetland has a great role in preventing the flood, landslide by raising the river edges and working as natural defence armour. The rivers not only reduce the drought, but also help prevent temperature increase and provide life of living creatures. The only way to protect and save wetlands from natural disaster

and make the life happy is to conserve wetlands and associated resources.

While wetlands are of immense importance for the population living around the urban wetland areas, the Government of Nepal has stipulated two approaches for their management, conservation and sustainable utilization on the ground. Nepal's constitution has envisaged government at three levels. Firstly, in case of wetlands under the federal government as described in Schedule-5, the goods and services produced by wetlands should be equally distributed among the communities sharing that particular wetland. Secondly, there are also some wetland areas extending in two or more than two Palikas and provinces. In such cases, the federal government should coordinate all management activities. Also, the Palikas must coordinate to protect, conserve, and manage any transboundary wetlands in their areas. Regarding the coordination of the wetland, government at different tier should provide equitable access to the local communities and ensure that the benefits are distributed among the concerned local communities. The local governments should ensure that they use every means to involve, engage young generation in the conservation works related to wetland management.

Due to bulging population growth, migration and urbanization, the areas of the wetland are on dual pressures. On one hand, the wells and ponds of the village have already been drying out as people are migrated to the city from the village. On the other hand, there is an increasing demand for water in the city and the level of ground water is decreasing due to excessive extraction of groundwater. The problem of flood victims is increasing because the rain water is not percolating to the grounds due to more buildings and all-weathered roads. Today, the technology has changed the life style of the urban people rapidly. These people have to work from dawn to dusk and are losing their life levels every day because they have to be in a queue for drinking water for 3-4 hours everyday.

Opportunities of Wetlands Management

Wetlands are the sources of multiple environmental services. Wetlands are biodiversity hotspot. They are also the sources of drinking water, irrigation, fishing, and also attractive

destination to domestic and foreign tourists as well. As Nepal has just entered into federal state with three tiers of the government, this is the right time to address the wetland issues with right policies and programs. The present government is committed to "*Prosperous Nepal: Happy Nepali*" while there is a huge chance to conserve, manage and utilize the wetland resources for the wellbeing of local communities, local governments and thus improving the living standards of Nepali in general and national economy in particular.

Many mayors and deputy-mayors of local governments have envisioned the concept of smart city for their Palikas and wetland conservation could be one of the entry points for sustainable rural development. In the meantime, Nepalese people are moving forward with education, sustainable development and prosperity which is increasing water demand. Therefore, to make our place clean and prosperous, there is a need to save the sources of water i.e. wetlands, and the utilization of wetland resources such as fish, fodder, firewood, fibre, fruits and many others. Special attention should be given to avoid the negative impact of infrastructural development of the city area as well as the negative impact on the water source and their perennial attributes, cultural values and originality.

In doing so, the local community should evaluate the contribution made by wetland ecosystem and give importance to environmental security for the sake of sustainable future, sustainable development, and wise use of resources, and even for more resilience of the society from the impact of climate change. Increasing agricultural production, managing biological diversity, distribution of benefits equally and promoting the concept of Ramsar sites is the minimum condition. In this backdrop, the federal, province and local governments should formulate a separate wetland strategy and coordinate with relevant stakeholders including local wetland dependent communities for the welfare of people and the wise use of wetlands and wetland resources.

Conclusion

Wetlands are popularly known as biodiversity hotspot, eternal source of environmental services and important source of livelihoods for

communities dependent on its' resources. In many instances, wetlands are cross-cutting in scope and therefore wetlands conservation in isolation and by an individual or institution is not possible at all. Wetlands are also severely affected by climate change and global warming. Therefore, it is also imperative to reduce the vulnerability to climate change and increase resilience of wetlands ecosystem. In the spirit of constitution of Nepal,

it is highly imperative to revise the present wetland policy and design a new, innovative and smart program. New smart program should be internalized by the local, province and federal governments. The internalization is a prerequisite. Similarly, a robust institutional mechanism is also equally important for long-term conservation, management and wise of wetland resources in Nepal.

Wetlands and Ethical Values

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Nepal is a small country that occupies about 0.1% of total land area of the world. As per the Nepal's Master Plan for Forestry Sector the number of ecosystems/unit area in Nepal is probably greater than in any other countries in the world.

Nepal is at the center of the 2500 km long Himalayas that extend from the Namcha Barwa in the east to Nanga Parbat in the west. Since it is at the middle of the monsoon climate region, its resources (both natural and cultural), ecosystem services, endemic biodiversity and cultural heritage are unique and valuable assets in the region.

Superlative Wetlands

Nepal's wetlands have some fascinating facts and attributes which should be recorded in the book of superlatives, i.e. the *Guinness Book of World Records*. Many of them are known while others are yet to be known. For example, Rukum and Kaski are the districts of lakes and ponds; Rukum is the district of *Baunna Tal Tripanna Pokhariko Jilla* (the district of fifty-two lakes and fifty-three ponds) whereas Pokhara is the *Talai-Talko Sahar* (the city of lakes). Some of the superlative characteristics of Nepal's wetlands are briefly mentioned below.

1. Tilicho (altitude = 4919 m & area = 354 ha) is the highest-cum-largest freshwater lake

at the southern slope of the Hindu Kush Himalaya region.

2. The Sarus *Grus antigone*, tallest and largest flying bird (height = 1.65m) uses Nepal's Terai as its habitat.
3. The bar-headed goose *Anser indicus*, the highest-flying bird uses the Himalayan wetlands as the breeding ground. It has been recorded flying at an altitude of 10,175 m.
4. The Koshi river floodplain is the habitat of wild Asiatic buffalo, the last surviving population of wild water buffalo in Nepal. The wild buffalo is the progenitor of domestic water buffalo.
5. The argali or *Nayan*, *Ovis ammon hodgsonii* is the largest species of the sheep in the world with the standing height of 110-120 cm and weight of 110-158 kg. Its largest herd is found in Nepal. Similarly, Yak, *Bos mutus* is found foraging up to 6,100 m in the Himalayas. The wolf, marmot, snow and leopard are found at an altitude of 4,600 m and above at the catchments of the glacial lake.
6. Nepal's rivers are good for cold water fisheries. The rainbow trout is farmed at the height of 2,000 m and the Kimura *Coraglanis kishinouyei*, a local species of

fish is found at an altitude as high as 3000 m in the Dudhkoshi river, snow trout and spotted trout (*Asla*) at Rara at an altitude of 2,990 m. Likewise, a species of *Schizothorax* small in size is found at an altitude of 3,323m along the Langtang stream in Rasuwa district. Prof. Jivan Shrestha reported that the largest fish, Gounch, *Bagarius yarrelli* weighting 240 kg was recorded in the Karnali river. She also reported the occurrence of the smallest fish, Zebra fish (or *Chelwa* in Nepali) *Brachydanio rerio*. Its size is about 50 mm and weight, about 2-2.5 gram. Thus, Nepal's wetlands provide habitat to both the largest and the smallest fishes.

7. Jumla Marshy, a local variety of rice is grown at the highest altitude of 3,050 m in Chhumjyu of Jumla district. This rice belongs to the Japonica group. This local species of rice is resistant to cold weather. The first day of showing seeds in the nursery is a big ceremony for the people of Jumla and people try to return home for this ceremony as far as possible. The crop is grown in an original way such as soaking the seeds on 26 March (12 Chaitra, Nepali calendar), draining seeds on 30 March (16 Chaitra,) and then broadcasting the sprouted seeds in the nursery bed on 3 April (20 Chaitra).
8. The floodplain wetlands in the Terai provide habitat for wild rice and the wild relatives

of the cultivated rice. The wild rice species are *Oryza rufipogon*, *Oryza officinales*, *Oryza nivara* and *Oryza granulata*. The other wild relatives of rice community are *Hygroryza aristata* and *Leersia hexandra* which are used as grasses.

9. Nepal has many riverine wetlands. The *Men Chu*, one of the two tributaries of the Arun River originates from the highest altitude of 8,012 m in the Tibetan plateau at the northern side of Mt. Gosainthan.

Nepal's Ramsar Sites

Nepal has 10 Ramsar sites (Ramsar sites means the Wetlands of International Importance). These sites occupy some 60,561 ha of land, which is 0.4% of Nepal's total area. These sites occupy about 4.8% (60,561 ha.) of the total wetlands in Nepal. They are found in all provinces. Province 1 has 3 Ramsar sites and Province 3 & 6 each has 2 sites. The rest are distributed in other provinces. The Koshi Tappu shares the boundaries of Provinces 1 and 2. The Ramsar sites are also distributed over all 5 ecological zones- the Himalaya, High Mountain, Middle Hills, Chure and Terai. The site that occupies the largest area is the Lake Cluster of Pokhara Valley, which occupies some 43.1% of the area, Koshi Tappu trailing behind by 28.9%. The third largest site is the Gokyo & Associated Lakes, which covers 12.8% area of the total wetland under the Ramsar sites (Table 1).

Table 1: Coverage and Distribution of Ramsar Sites

S.N.	Ramsar Sites	Province	Area (Ha)	% of Ramsar Sites
1	Beeshhazarr & Associated Lakes	3	3,200	5.3
2	Ghodaghodi Lake Area	7	2,563	4.3
3	Gokyo & Associated Lakes	1	7,770	12.8
4	Gosainkunda & Associated Lakes	3	1,030	1.6
5	Jagadishpur Reservoir	5	225	0.4
6	Koshi Tappu	1 & 2	17,500	28.9
7	Lake Cluster of Pokhara Valley	4	26,106	43.1
8	Mai Pokhari	1	90	0.2
9	Phoksundo	6	494	0.8
10	Rara Tal	6	1,583	2.4
	Total	-	60,561	100.0

Area under Wetlands

Table 2 below shows the area coverage under different types of wetlands. As shown in the table, the total area covered by wetlands in Nepal is 1,254,963 ha or 8.2% of the total area of Nepal. The data includes water bodies as well as its

surrounding catchment area. The largest area (3.67 %) is under alpine wetlands i.e. glaciers and glacial lakes. Trans-zonal area (area under rivers, streams, swamps and floodplains) occupies the second position at 2.29%. Detailed information along with the sources of information is presented in Table 2.

Table 2: Total estimated area of Nepal's wetlands

(Total area= 147,181 sq km or 14,718,100 ha.)

S.N.	Topographic zone	Wetland type ¹	Area (ha)	Percent	Source
1.	High Himalaya & Mountain	Glaciers, glacial lakes	539,800 ²	3.67	Mool et al. (2001)
2.	Middle mountain	Lake, pond, marsh, fall, hot spring	3,190 ³	0.02	Bhandari (2009; Annex C)
3.	Siwalik	Lake, pond, daha	3,416 ⁴	0.02	Bhandari (2009; Annex D)
4.	Terai zone	Lake, pond & marsh	178,112 ⁵	1.21	Bhandari (2009, Annex E)
5.	Trans-zonal area	River, stream, floodplain & swamp	337,500 ⁶	2.29	Crude estimate only
		Reservoir, barrage & canal	192,945 ⁷	1.31	Bhandari (2009, Annex F)
Total			1,254,963	8.52 %	

Source: Bhandari (2013)

Why and How Wetlands are Valuable?

Wetlands are the sources of many products, uses and values. The values range from optional to non-use values. Besides, they provide us with products such as fishes, grains, medicinal and

aromatic substance, wildlife, timbers, non-timber forest products and others. Above all, wetland ecosystem provides services such as provisioning (direct use), regulating (ecological functions), cultural and support services. The details are presented in Table 3.

¹ Data on small aquacultural ponds, seasonally flooded areas, peatlands, hot springs (thermal wetlands), permafrost and underground water are not included. The total estimated area is based on limited data and therefore are indicative only.

² The area is based on information based on Mool et al. (2001). Glaciers and glacial lakes come under a special category of the Himalayan wetlands.

³ The estimate is indicative only. This includes all wetlands regardless of their size. The basis of the estimate is given below. For example, Annex D (Bhandari, 2009) shows that there are all together 182 sites. The area of only 54 sites is known. Some 10 sites have extreme value of about 2,660 ha. Since the extreme value inflates the calculation, they were not taken into account. So only 44 sites, which make up 146 ha are used to calculate the mean. The mean, which is 3 ha, is taken here as a constant value (K) and assigned to all the sites without any known value. The total area under 128 sites is 384 ha. This is how the total sum of 3,190 ha has been calculated.

⁴ Wetlands of all size are included.

⁵ Wetlands of all size are included.

⁶ According to the "Altitude Geography: Effects of Altitude on the Geography of Nepal by Ram Kumar Panday. Lalitpur: Center for Altitude Geography; 1987: 85), the total length of the rivers is 45,000 km. On an average, the average width of a river is equivalent to the average width of some 400-500 suspense bridges in Nepal. The overall average of a suspense bridge is 70 meters. These data were used to roughly calculate the area under the riverine wetlands. These wetlands cross all the zones and therefore are listed as trans-zonal area.

⁷ The command area of the canal (including deep rice paddies) is included. They are, also trans-zonal. Reservoir, barrage, floodplain and canals are categorized as riverine wetlands.

Table 3: Total Benefits Obtained from Wetlands

	Use Value	Non-use value		
	<i>Products</i>	<i>Ecological Functions</i>	<i>Option values</i>	<i>Existence Values</i>
1.	Fisheries	Nutrient retention	Potential use	Biodiversity (gene)
2.	Agricultural resources	Water discharge & recharge	Future value	Culture/heritage
3.	Forest resources	Storm control		Bequest value
4.	Forage resources	Shoreline stabilization		Research/Education
5.	Wildlife resources	Micro-climate stabilization		
6.	Water supply	Biomass export		
7.	Peat/energy	Sediment retention		
		Flood control		
		Recreation/tourism		
		Water transport		

The above Table shows us that wetlands provide so many benefits and services to human beings as well as to the ecosystems. In other words, human beings are totally dependent on wetland for so many benefits and uses. Therefore, human beings have some duties and responsibilities towards wetlands and their conservation and wise use. They should play an important role in their sustainable uses. If their duties are not performed honestly and sincerely, then the whole ecosystem becomes in jeopardy or becomes very vulnerable biologically and culturally. Therefore, human beings need to do something for their sustainability. Duties, rights and responsibilities toward their management and conservation can be listed as follows.

1. Let us identify and know what exist around our wetlands. Our knowledge about them is a pre-requisite to move forward.
2. What is their current status? Do they have any threats for their existence? What are the causes? What is the degree of human pressure for their survival?
3. It is important for all of us to share the problems of, threats and challenges to wetlands and then set prioritize our duties and responsibilities.
4. People, particularly the users, should be made aware of their protection, importance, values and uses.
5. In collaboration with local users, it is important to prepare a realistic plan for their management and sustainable uses.

Ethic in Wetlands

Ethic is a belief that considers that every human individual, each human society and every forms of life are interdependent to each other. They are the part of the whole planet. All are equal, and none is more or less. Thus, each person has to care for others and for future generations. Ethic asserts our duty and responsibility towards other forms of life with which we share this planet. Ethic also recognizes that nature has to be cared for in its own right, and not just as a means of satisfying human needs (Ashman, 1993).

In other words, the above statement can be simplified to say that human beings are a part of the community of life, made up of all living creatures. According to the document *Caring for the Earth* (IUCN/UNEP/WWF, 1991:14)

"Every life form warrants respect independently of its worth to people. Human development should not threaten the integrity of nature or the survival of other species. People should treat all creatures decently and protect them from cruelty, avoidable suffering, and unnecessary killing. People should conserve ecological processes and the diversity of nature and use any resource frugally and efficiently, ensuring that their uses of renewable resources are sustainable. Every generation should leave to the future a world that is at least as diverse and productive as the one it inherited. Development of one society or generation should not limit the opportunities of other societies or generations."

Therefore, ethic is very important in wetland conservation & management. The wetland

manager should clearly understand the meaning of ethic. Ethic is the set of moral principles that guides a person's behaviors. Ethic reflects belief about what is right, what is wrong, what is just and what is unjust, what is good, what is bad in terms of human behaviors. Our aim is to find out what is good, what is just and what is right. It sets the standard of what is acceptable and what is not. Ethic allows an individual to make the right decision. Without it, it will be difficult to regulate life and act responsibly because ethic influences behavior. The good, just and right thing is to prevent, stop and reverse the loss and degradation of wetland resources. Therefore, ethic is well-founded standard that makes the actions right or wrong. The choice and use of this standard is guided by integrity, honesty, respects, compassion and loyalty of a wetland manager. But there is no consensus, no single and universally accepted conservation ethos for this goal. Wetland managers, therefore, should develop a personal ethical position to achieve this goal.

Generally, people are mixed up between ethic and religion. Neither ethic is religion nor can it be confined to religion. Ethic is also not the same as following the law, either. "Being ethical" is not the same as doing "whatever society accepts". In any society, people accept standard that are, in fact, ethical. But the standard of behaviors can deviate from what is ethical. Sometimes an entire society can become ethically corrupt.

Applying Ethic in Wetland Conservation

In the literature, there are a multitude of ethical theories that primarily offer arguments for/against the conservation of resources. Nelson (nd) has provided over a dozen of theories on ethic. Among them one theory that is relevant to, and supports arguments for, the wise use of wetlands is deep ecology. According to the theory of deep ecology, humanity is the part of nature. In other words, the world does not exist as a resource to be freely exploited by humans. The ethic of deep ecology holds that a whole system is superior to any of its parts. Humans have no right to reduce this richness and diversity except to satisfy vital human needs. The well-being and flourishing of human and non-human life on the Earth have

value (intrinsic values and inherent values) in themselves. These values are independent of the usefulness of the non-human world for human purposes. The theory can be further simplified as follows.

1. The universe is made up of many communities. Humans are ordinary members of the biotic community. Each gives rise to and supports others.
2. Therefore, humans are not a superior species with the right to manage and control the use of nature.
3. Humans are dependent on the well-being of nature for their own physical and psychological well-beings. As a consequence, there arises a natural inclination to protect non-human life.
4. Arne Naess of Norway, who propounded the concept of deep ecology said, "The more diversity, the better".

The theory is directly opposed to anthropocentrism (Humans are both separate from, and superior to nature. They were thus morally justified in manipulating it as much as was required in order to maximize human welfare) and utilitarianism (wetlands are valuable only for its utility for people including happiness & pleasure).

Religion also places a great attachment to ethic. For examples, in **Hindu Religion**, God creates objects in the Universe & resides within all objects. So, Hindus worship every object in the nature. **Islam** believes that there is only one God. He has created everything in the world. All are God's dependants & those are beloved to God who loves God's dependants. According to **Christianity**, God created Heaven and Earth and all things found therein. So, the natural state of our universe should remain as it is because it is all God's creation. **Buddhism** always pleads for compassion for the environment and ethics of universality. **Totemism**, the religion common in the Pacific Region, shows a close bond between animals, plants and humans.

In the end, the first and foremost duty is to set the goal of wetland conservation. Generally, the

accepted goal can be: **Prevent, stop & reverse the loss and degradation of wetlands**. In order to achieve this goal, we can fix an ethic that is: **Respecting and caring for the health of wetland ecosystem**. While applying the ethical value, it is essential to know or attempt to answer some of the questions such as

1. What we ought to do (duties & responsibilities) for wetlands?
2. Why and how wetlands are valuable?
3. Which value we should hold?
4. Why should we conserve non-human environment?¹
5. How we ought to conserve those values in thinking, action and policy?
6. How we should safeguard them?

Reference

Ashman, John (1993). "Ethics in Conservation". Journal of the Society of Archives, Vol. 14.No. 1,1993.

Bhandari, Bishu (1998). An Inventory of Nepal's Terai Wetlands. Final Report. Kathmandu: IUCN Nepal

Bhandari, Bishnu B. (2013). A Glance at the Wetlands of Nepal. NWS Series 6. Nepal Wetlands Society.

IUCN/UNEP/WWF (1991). Caring for the Earth: A Strategy for Sustainable Living. Gland, Switzerland.

Mool, Pradeep; Samjwal R. Bajracharya; and Sharad P. Joshi (2001). Inventory of Glaciers, Glacial Lakes and Glacial Lake Outburst Flood: Monitoring and Early Warning Systems in the Hindu-Kush Himalayan Region. Kathmandu: ICIMOD.

Nelson, Michael P. (nd). Introduction to Environmental Ethics. Biodiversity Project Ethics for a Small Planet: A Communication Handbook

1 The existence of human beings depends on the existence of non-human environment. Then non-human environment means the community of plants, soils, rocks, water, air, light and space. The critical question is why are they so important for us? For example, they are important for us because they provide us food, shelter, cloth, water, light and air for our survival. Similarly, animals are also equally important for all of us - cows and buffaloes give us milk, bullocks for draft power. Wild animals give us protein and they enhance our aesthetic values and so on. It all leads us to think that without the protection of the non-environment, human beings can't survive at all. Therefore, the protection of non-human environment is vitally important for the survival of human beings.

Sustainable Use of Lake in Nepal

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Abstract

The paper provides the distribution of lakes of Nepal and discusses how these lakes play a significant role in sustainable development of resources. It makes the valuation of lake-related biodiversity and attempts to explain the ways and means to integrate biological, ecological and economic reasoning into lake conservation and its sustainable utilization. Large trans-Himalayan wetlands such as Rara, Phoksundo, Gokyo and Tilicho have great touristic value as they are migration fronts and staging areas for many water birds including Bar-headed goose (*Anser indicus*), Brahminy duck (*Tadorna ferruginea*), Demoiselle crane (*Anthropoides virgo*) and other water birds. They are also sites of religious pilgrimage of intrinsic touristic value. The future of biodiversity conservation and ecotourism development of Nepal is inextricably linked with the conservation of habitat of these wetlands. So consideration of borderline habitat is necessary for the survival of lake water dependent terrestrial animals such as Red Panda (*Ailurus fulgens*) and Musk deer (*Moschus chrysogaster*). This paper also examines specific problem of the conservation of biodiversity in large subtropical lakes of Pokhara valley as well as tropical lakes of Chitwan (Beeshazar), Kailali (Ghodaghodi), Kanchanpur (Ranital) and Maipokhari of Ilam district. Furthermore, special consideration is given to borderline habitat which is necessary

for the survival of the wetland dependent large charismatic animals such as swamp deer, wild buffalo, otter, crocodile, turtle, eel, mahseer and Himalayan newt. In this paper specific problem connected with invasive weeds and exotic fishes affecting ecosystem and biodiversity of lakes of Nepal are also discussed, data gaps identified, and recommendations given for their conservation.

Introduction

Nepal is a land-locked country, where snow-clad Himalayas, eternal glaciers, ice-cold torrents, snow-fed and rain-fed rivers and lakes contribute much of its hydrosphere. These vast stretches of wetlands support many and varied form of freshwater life. No detailed information is available at present about the diversity of animal life living in different water bodies of trans-Himalayan wetland. The need and opportunity for the study of freshwater resource and its conservation and management are enormous, indeed. An interdisciplinary research on the conservation and management of lake and its biodiversity as well as possible utilization of them as resource will be of great help to abate hunger and nutritional deficiencies in mounting population of Nepal (Shrestha, 1988).

The “high water” of highland Nepal forms the rock base of Himalayan wetland. Up to this time our knowledge about physical, chemical and

biological features of these waters are meager, indeed. The complex hydrological cycle in the Himalayan wetland influences all forms of animal life and their food chain. From the human standpoint, its main influences are on climate, water supply, forest, fisheries and navigation. The wild and scenic lakes of Nepal create countless opportunities for bird watching, recreational fisheries and wildlife ranching. More progressive, dynamic and imaginative technique has to be developed to preserve these placid waters (Shrestha, 2005 a, b and 2009).

Ecogeographical Distribution of Wetlands in Nepal

Nepal is a small country, roughly rectangular in shape, with total area of approximately 147,181 sq. km. It lies between 80°15' and 88°10' East and 26°20' and 30° 10' North and is bounded in the north by China, and in the east, west and south by India. Based on topography and climate, Nepal can be divided into four major ecological zones; lowland, midland, highland and trans-Himalayan zone. These eco-zones contain about 5,358 lakes of different size (NLCDC, 2007).

The Terai belt (or low land zone) covers a narrow strip of land along the southern edge of the country. The region is characterized with large rivers and their floodplains with dense tropical to sub-tropical vegetation interspersed by areas of thick grasslands. In the floodplain of Koshi River of this eco-zone, important and the first Ramsar site, Koshi Tappu lies.

The midland zone consists of series of hill ranges, steep rivers and hill-streams and inter montane basins stretching across the middle of the country ranging from 900 m to 2,500 m in the upper sub-tropical and temperate areas. Midland zone is dotted with many spectacular wetlands; most remarkable among them is Maipokhari and Khaptad (Shrestha, 1994a).

The highland zone (about 2,750 m and up) includes all the northern region of Nepal and has a predominantly snow-fed river clad with coniferous forest such as rhododendron and birch, the alpine meadow zone and barren rocky slopes to the permanently snow-capped mountain. The trans-Himalayan zone, relatively a small area, lies to the north of the main Himalayan chain in

western Nepal. The Himalayan zone lies at the extreme southern edge of the great Tibetan plateau where the annual rainfall is very low and thus comprising a micro-climate type of (semi-arid) vegetation. In highland zone many spectacular wetlands such as Rara, Tilicho, Gokyo and Shey-Phoksundo are found (Shrestha, 2005a).

Nepal lies in between two large bio-geographical realms which are bordered along the Himalayas i.e., the Palartic Realm in the northern region and Indo-Malayan and Oriental Realm in the southern tropical region. Nepal is a land of great natural diversities because of its unique geographical setting (Shrestha, 2003). Therefore, within a short distance of about 200 km, one can have contrasting environment of humid-sub tropical Terai in the south to the permanently snow-capped mountain in the north. The various aspects of slopes, altitudinal gradation and the latitudinal location of the mountain have created numerous macro and micro-climates which, in turn, have reflected on the terrestrial and aquatic fauna and flora. Therefore, extremely rich fauna and flora occur in the watershed and wetlands of major rivers of Nepal (Shrestha, 1994b).

Of all Nepal's freshwater habitats, lakes are the most vulnerable and most threatened ones. The lake ecosystems of Nepal have been the target of physical alteration, usually deforestation and conversion for other uses. However, in recent years efforts have been made to protect segments of wetlands near national parks and wildlife reserves. Examples of such efforts are Shivapuri Watershed Area, Annapurna Watershed Area, Koshi Tappu Wildlife Reserve and Lake Rara. In man-made wetlands, endangered and threatened animals such as swamp deer, wild buffalo, hispid hare and crocodiles have been benefactors of these efforts (Shrestha, 2005b, 2009).

If one examines wetlands of Nepal, it becomes apparent that these areas represent a small fraction of land area. Wetland ecosystem and their associated communities, however, harbor an unusually large percentage of unique plants and animals. In the past, wetland habitats of the Gandaki, the Koshi, the Karnali and the Mahakali floodplains and the endangered, threatened and unique plants and animals were given little or no importance by planners and developers of

Nepal. Unfortunately, this has led to the wholesale destruction of many pristine wetland habitats and their associated fauna and flora.

Wetlands and Their Types

The wetlands of Nepal can be classified as (i) open water bodies, (ii) closed bodies, ponds, reservoir and oxbows, (iii) seasonal rain-filled water bodies, bogs, swamps, flooded areas and paddy fields. Many thousands of shallow, water filled depressions and river capture lake that dot the upper mountain zones, the most important ones being Lake Rara, Gokyo, Tilicho and Gosainkund. These wetlands serve as a vast waterfowl breeding ground, even the sewage water-filled Sundarighat in the Kathmandu Valley. The Tank of Sundarighat is serving as a resort of migratory wild-ducks and water birds. Conservation of such area is essential for the health and prosperity of the people and nature education.

The prolific wetlands are scattered throughout country's most fertile agricultural areas in the Terai. Among them the most noteworthy ones are Ghodaghodi Tal of Kailali, Ranital of Suklaphanta and Mai Pokhari of Ilam. Recently many wetlands have been drained and turned into cropland. Koshi Barrage, for example, is a focal point in the central flyway used by thousands of ducks, geese and cranes during their annual migrations. But 40 percent of the original wetlands in this basin have been destroyed.

The inland marshes of the Karnali and Mahakali rivers provide both feeding areas for wading birds and wintering grounds for waterfowl. In addition, they provide breeding ground for such species as rails, coots, teals, mallards and other endangered wild ducks. These wetlands are also very important for wildlife. But the conversion of the marshes to agricultural land is significantly affecting both waterfowl and wildlife population. Below are presented some important types of wetlands in Nepal.

(a) Forested Wetlands

Nearly 80 percent wetlands of periodically flooded bottomland hardwood forests that once existed in the lower Koshi, Gandaki, Karnali and Mahakali valleys have been lost to agricultural

land. The remaining area still serves as the major over-wintering grounds for most of the continent's ducks and for virtually all of the wood ducks in central Nepal. They also provide rich habitat for a wide range of other wildlife, and also spawning and nursery areas for fish. Even today these remnants are shrinking as tracts are levelled, drained and converted to farming.

The wetlands of Gandaki Pradesh, particularly in the Pokhara Valley, are covered with sub-tropical forest by regulating the flow of freshwater which is essential in maintaining the productive fisheries. But the wetlands in the valley are under great pressure from water mills and agriculture.

(b) Marshy Wetlands

Marshes and swamps are important wintering areas for waterfowl and breeding grounds for wading birds. They are also key spawning and nursery areas for most of our commercial and sport fish, including shellfish.

(c) Managed Wetland

Managed wetland includes pond, bog, fish farm, irrigation canals and reservoirs. These wetlands are heavily stocked with fish and used for integrated aquaculture.

(d) Artificial Wetlands

Artificial wetlands are those that have been intentionally or unintentionally created through such activity as stone mining, grading, filling and construction of dam.

Tangible Value and Wise Use of Wetlands

No part of our landscape provides so many benefits at so little cost to the public as Nepal's wetlands - our swamps, marshes, bottomland, forests and other types of water-dominated areas support livelihood of poor people at large. Such life supporting benefits include:

(a) Waterfowl Breeding: Over fifty thousand ducks nest and breed annually in eastern and western Nepal. These areas, when combined with similar habitats in the Asian wetland, account for 30 -50 percent of the continent's breeding duck population in Nepal's wetlands the following.

(b) Habitat for waterfowl: Some thousand wildfowls

are seen winging their way across the Asian wetland flyways and nearly thousands of wildfowls such as Bar-headed goose (*Anser indicus*), Mallard (*Anas platyrhynchos*), Pintail (*Anas acuta*) and so on winter in the flooded bottomland forests and marshlands throughout the Gandaki, Koshi and Karnali river basin.

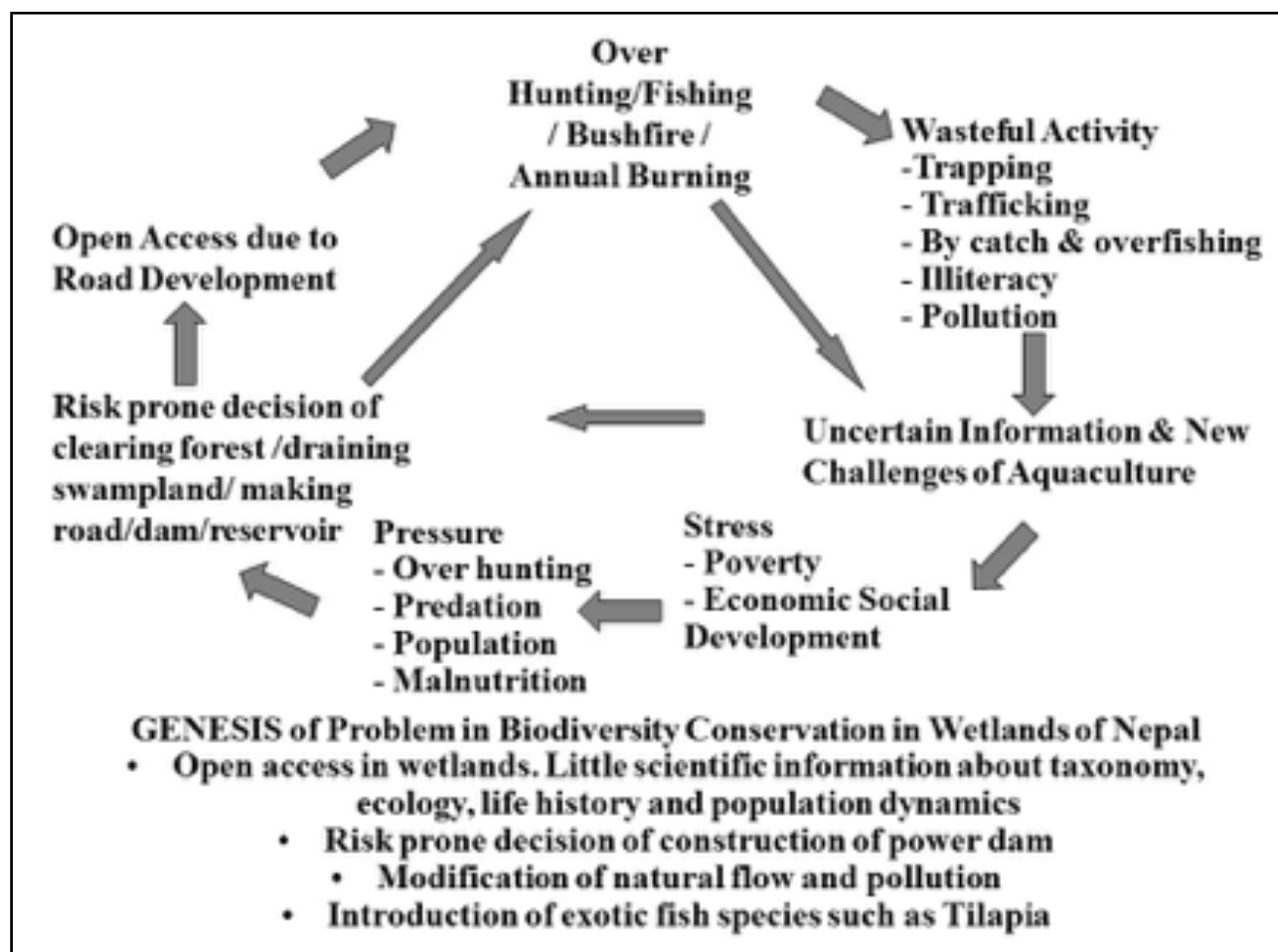
(c) Wildlife Habitat: Wetlands provide food and shelter for a great variety of fur-bearing animals such as otters (*Lutra perspicillata*, *Aonyx cinera*) and other wildlife.

(d) Habitat for Threatened and Endangered Species: Wetlands are the home for at least one-third of the threatened or endangered species such as wild buffalo (*Bubalis bubalis*), swamp deer (*Cervus duvauceli*), crocodiles (*Crocodilus palustris*, *Gavialis gangeticus*), Indian softshell

turtle (*Aspideretes gangeticus*), Swamp partridge (*Francolinus gularis*) and smooth otter (*Lutra perspicillata*) and so on.

(e) Shrimp and Shellfish Production: Shrimp (*Paenus*), shellfish (*Unio*, *Plia*), crabs (*Cancer*) and edible tree frogs (*Hyla*, *Paa*, *Rhacophorus*) are commercially important. They rely on swamps and marshes for spawning and nursery.

(f) Freshwater Fish: More than 232 species of freshwater fish are found in Nepal. Among them wetlands provide ideal habitats for Eel (*Anguilla bengalensis*), climbing perch (*Anabas testudians*), Puffer (*Tetraodon cutcutia*), Walking catfish (*Clarias batrachus*), Mud eel (*Amphiphous cuchia*), Murrel (*Channa gachua*), Toad fish (*Chaca chaca*) and others.



Conclusion

This paper stresses a wise use of lakes of Himalayan foothills of Nepal. It argues that wise use will be achieved largely by maximizing the area of lake protection and maintaining wetlands as functional units in the landscape. Their wise use in a developing country like Nepal should be integrated with total rural development activities (Shrestha, 1992, 1996).

In conclusion, research and training are major issues in the management of wetland bio-diversity in Nepal. Furthermore, environmental impact assessment, which should be made as prerequisite for any project planned for wetland development, can only be done if there is adequate information obtained through research. In the field of systematic natural history of wetland biota, there is a declining state of research and innovation in developing world including Nepal. Schools and universities suffer from the lack of liberal education in this subject. Despite widespread awareness of biodiversity lip service is paid for the importance of conserving biodiversity of wetlands. There is no government officer who can authoritatively identify planktons, fish, amphibian, reptile, birds living in wetlands. It is difficult to conserve species without first having located, photographed, identified and studied them. There is a vital need to study systematic biology. The taxonomy or systematic biology is the discipline which is needed as grammar and syntax of biodiversity of wetlands.

Recommendations

The following recommendations are put forward for the effective conservation of wetlands in Nepal.

1. Assess wetland of regional, national and international importance.
2. Identify endangered wetlands under high pressure or stress, for example, sites for fishes, terrestrial and aquatic tree frogs, salamanders, turtles, crocodiles, dolphins, otters, butterflies, dragon flies, and water fowls.
3. Make survey and inventories of rare and endangered plants and animals of wetlands such as wild variety of rice (*Oriza rufipogon*).
4. Record impact of climate changes on bio-diversity through different time.
5. Mount nationwide wetland monitoring program, make wetland restoration assessment for target species and present holistic eco-model.
6. Determine the minimum wetland area or configuration needed to maintain bio-diversity in upland, midland and lowland Nepal.
7. Determine cumulative impact due to hydropower development activity on wetlands.
8. Provide mitigation measures for the lost habitats, manage unwanted predatory exotic fishes and overgrown weeds in lakes.
9. Enhance and restore existing wetland habitat with the application of bio-engineering principles (Pokhara lakes).

References

- DOFD, 2009. Annual progress report. Directorate Fishery Development, Central Fishery Building, Kathmandu.
- Hickel, B. 1973. Limnological investigation in lakes of the Pokhara valley, Nepal, Int. Rev. Cress. Hydrobiol, 58: 569-792.
- NLCDC, 2007. Lake Inventory of Nepal. National Lake Conservation Development Committee. Government of Nepal.
- Shrestha, T.K. 1988. Biology, status and conservation of the Ganges dolphin *Plantanista gangetica* in Nepal. In: Biology and Conservation of River Dolphin (Eds. W.F. Perrin, R.L. Bronell, Jr., Zhou Kaiya and Liu Jiankang). Occasional Papers of IUCN, Species Survival Commission. No. 5, pp. 70 76.
- Shrestha, T.K. 1989. Impact of Tourism on the Himalayan Ecosystem of Nepal. In: Impact of Tourism on Mountain Environment. pp. 41-61. (In S.C. Singh ed.), Research India Publication, Meerut, India.
- Shrestha, 1990a. Rare fishes of the Himalayan waters of Nepal. J. of Fish Biology 37:

- 213-216. Supplement A. Academic Press, London.
- Shrestha, T.K. 1990b. Status, ecology, conservation and management of genetic resources of crocodiles of Himalayan rivers of Nepal. In: Himalayan Environment, Resources and Development (N.K. Shah, B.D. Bhatt, R.K. Pandey eds.). Shree Almorah Book Depot. Almora, India. pp. 332-350.
- Shrestha, T.K. 1992. Ranching Crocodiles in the Himalayan Waters of Nepal, Proceeding of IUCN, Crocodile Specialist Group.
- Shrestha, T.K. 1992. Conservation status of swamp partridge, *Francolinus gularis* in Nepal. In Perdix VI, First International Partridge, Quail and Francolin Symposium, M. Birkan, G.R. Potts, N. Aebischer and S. Dowell, (Eds.) Giber Faune Sauvage, Paris.
- Shrestha, T.K. 1993. Status of Wetlands in Nepal Himalayas and Biodiversity, Geographer's Point, J. of Geography, Kathmandu, Vol. 2(1): 8-17.
- Shrestha, T.K. 1994a. Habitat Ecology of the Mai Pokhari Wetlands in Nepal and Management Plan for Survival of the Himalayan Newt *Tylototriton verrucosus*. In: W.J. Mitsch (ed.), Global Wetlands Old World and New. Elsevier Science, U.S.A. pp. 857-862.
- Shrestha, T.K. 1994b. Wetland fauna in Nepal. In: Bhandari, B., Shrestha, T.B. and McEachern, J. (eds.) Safeguarding Wetlands in Nepal. Proceedings of the National Workshop on Wetlands Management in Nepal. IUCN. pp 41-52.,
- Shrestha, T.K. 1996. Wetland Use, Habitat Fragmentation and Their Impacts on Turtles in Nepal. International Congress of Chelonian Conservation - Gonfaron, France, SOPTOM, editor pp. 57-61.
- Shrestha, T.K. 2001. Wilderness and Biodiversity and Impact of Tourism on Royal Chitwan National Park. Britain Society, Policy and Environment, University of Leeds. U.K
- Shrestha, T.K. 2003a. Impact of Tourism in Chitwan National Park XXVIth International Congress of Game Biologist, Baraga, Portugal.
- Shrestha, T.K. 2003b. Anthropogenic impact on the habitat and distribution of swamp partridge *Francolinus gularis* in Nepal 3rd International Wildlife Management Congress. 1-5 December, Christchurch, New Zealand.
- Shrestha, T.K. 2003c. Endangered Gangetic Dolphin in Rivers of Nepal 3rd International Wildlife Management Congress. 1-5 December, Christchurch, New Zealand.
- Shrestha, T.K. 2005a. Ecological Implication of tourism in Big game of Nepal Himalayas. XXVIIth Congress of the International Union of Big Game Biologists Hanover Germany 28 August to September Wildlife Management Congress. Hanover Germany.
- Shrestha, T.K. 2005b. Impact of Habitat Fragmentation and Human Activity on Last Remaining Population of Wild Buffalo (*Bubalus bubalis arnee*) in Nepal. XXVIIth Congress of the International Union of Big Game Biologists Hanover Germany 28 August to September Wildlife Management Congress. Hanover Germany
- Shrestha, T.K. 2007. Present Status and Future Prospects of Ecotourism in Himalayan Wetlands of Nepal. In: Wetland. Debamitra Mitra (ed.) Wetland Conservation and Ecotourism South Asian Perspective. The Icfai University Press. Hyderabad, p. 162-180.
- Shrestha, T.K. 2009 Swampdeer activity in Suklaphanta Wildlife Reserve and Ranching Possibilities in Nepal. XXIXth Congress of the International Union of Big Game Biologists Russia, Moscow.
- Shrestha, T.K. 2017. Wilderness and Diversity of Life in Nepal's Chitwan National Park. B. Shrestha, Kathmandu, Nepal.
- Shrestha, T.K. 2017. Ecological Study of Fish Species at Rara Lake, Rara National Park, Nepal. A study report submitted to Department of National Park and Wildlife Conservation, Nepal Government.

Integrated Lake Basin Management in Action

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State of World's Lake

Together with other standing bodies of inland waters such as reservoirs, wetlands, ponds and the like, lakes contribute more than 90% of the readily-available liquid freshwater on the surface of our planet, making them the key components of global water resource systems. These standing bodies of inland freshwaters and their basins are managed for various purposes. Some are managed as sources of clean and safe water for drinking water supplies. Others are managed to maximize the production of fishery resources. Still others are managed to enhance the aesthetic and recreational values for tourism. Over time, these lakes would also face the need to restore the water quality and rehabilitate their ecosystem. Most of them, however, would be subjected to multiple management objectives intertwined with complex and sometimes conflicting, needs and approaches, often with inadequate management resources. The track record of sustainable management of such resources, therefore, has not been very impressive globally, particularly in developing countries. Most of them have been suffering from the deteriorating trend of water quality and ecosystem integrity, and as a result, the overall value of their very existence has been ubiquitously diminishing. With the

above in mind, this paper aims at informing the readers that management of lakes and their basins for sustainable resource development and use would require gradual improvement of the basin governance based on the concept referred to as Integrated Lake Basin Management (ILBM), or more precisely as Integrated Lentic and Lotic Basin Management (ILLBM or IL²BM), and gives an overview of the experiences and outcomes of its application between 2005 and 2017. An earlier version of this paper (Nakamura and Rast, 2016) was presented at an international workshop, “*Enhancing Water Management Capacity in a Changing World: Science Academies Working Together to Increase Global Access to Water and Sanitation*” held in Sao Paulo, Brazil in 2012, in which the concept of ILBM was presented based on an ILEC publication at the time on the subject (Nakamura and Rast, 2011), which was subsequently revised and updated (Nakamura and Rast, 2014).

Integrated Lake Basin Management

Definition

Managing inland water systems (lakes, wetlands, rivers, aquifers) for sustainable use is a complex challenge involving a range of interconnected

scientific, socioeconomic, political and environmental issues, often with conflicting and contradictory goals. The only reasonable approach for such cases is to pursue gradual, continuous and holistic improvement of basin governance, including sustained efforts for integration of institutional responsibilities, policy directions, stakeholder participation, scientific and traditional knowledge, technological possibilities, and funding prospects and constraints. The approach, as applied to lakes and similar standing bodies of water, is called Integrated Lake Basin Management (ILBM). ILBM takes the position that even the problems facing individual lakes cannot be properly addressed unless the fundamental issue of sustainable resource development, use and conservation facing the lakes is addressed globally, and with strong, long-term political commitment. The ILBM process also is designed for lake basin stakeholders collectively to fill the gaps between what has already been achieved, and what remains to be achieved realistically in continuing governance improvements over time. As discussed further below, the ILBM 'Platform' is a virtual stage for collective stakeholder actions over a long-time period, resorting to an ILBM approach as a strategic means of facilitating the gradual and continuous improvement of basin governance.

Lakes as Lentic Waters

Lakes and reservoirs are broadly considered to be "standing" or "static" water systems or, using a hydrologic term, they may be regarded as "hydrostatic" systems. In contrast, "moving" waters, such as rivers, can be regarded as "hydrodynamic" systems. Similar expressions exist in ecology literature. The descriptive terms are "lentic" and "lotic" systems. The meaning of "lentic" is basically the same as for hydrostatic, while the meaning of "lotic" is the same as for hydrodynamic. However, the lentic and lotic expressions have the additional connotation of their imbedded ecological functions. That is, the terms "lentic" and "lotic" infer the ecological properties unique to standing and flowing bodies of water, respectively. Ecologically, the lentic waters, either fresh or saline/brackish, have a particularly vulnerable and fragile property due in large part to their unique bio-chemic-physical features transcending to complex management challenges, i.e., *an integrating nature* (it receives

all forms of stress from almost every direction), *long water residence time* (the received stresses remain long and persistently); and *complex response dynamics* (the stresses change their form from one state to another within the water body, often not being readily noticed since, they take place in small increments). The natural lake-river systems, pond-stream systems, and wetland-feeder spring systems are strongly lentic-lotic in character. Managing a basin that consists mostly of a strongly lentic-lotic regime, for example, requires a different management approach than that for a basin consisting primarily of man-made hydraulic systems. The concept of ILBM, while having been derived from the term Integrated "Lake" Basin Management, is in fact a concept for lentic waters of all kind, and they are generally complexly intertwined with lotic waters, implying that ILBM needs to be expanded in scope to Integrated Lentic and Lotic Basin Management (ILLBM or IL²BM).

Ecosystem Services: A Useful Conceptual Framework

The wide range of resource values that lakes and other lentic waters provide to humans are fundamentally "ecosystem-derived". In other words, the goods and services provided for humans by these water systems are provided by the ecosystems, and virtually all ecosystems provide services essential for human health and economic well-being. The four classes of ecosystem service components as defined in the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment, 2005) are categorized into the following four services. They are:

- a. **Resources Provision Service** – represents the products people obtain from ecosystems, including water supplies, fish, crop irrigation, wood and fiber, fuel, hydropower generation.
- b. **Regulating Service** – represents such ecosystem processes as flood and drought mitigation, self-purification capacity, health provision, navigation routes, climate mediation, aquatic habitats, diverse food-chains, fertile lands, coastal ecotone buffer capacity.
- c. **Cultural Service** – represents such non-material qualities people obtain from

ecosystems, as aesthetic and scenic values, religious and spiritual values, historic sites, educational resources, etc., and

- d. **Supporting Service** – represents the capability to support all other ecosystem services, including heat energy, geological formation, nutrient cycling, primary production, physical formation, etc.

The main challenge for humans is to gradually attain a balance between the *resource provision services* and the *regulating services* comprising major components of the overall *ecosystem services* for which the concept of the ILBM serves as a useful foundation, except that the global balance between the resource provision services and the regulating services would have to be pursued over a much longer timeframe and with much broader spatial implications than the conventional notion of lake basin management.

Planning Vs Governance

Meeting the Management Needs: Scopes and Approaches in Planning

The possible reasons for, and purposes of, lake basin management would necessitate development of suitable frameworks for planning, with the goal of fulfilling the respective management requirements. Such plans may pertain to, for example, **a) resource development**, such as water supply and fishery activities, **b) resource value enhancement** for promoting tourism and recreational facilities, **c) decongest resource use** as in the case of regulating the excessive water withdrawal from the lake, or of reducing the rampantly constructed fish cages across the lake to an appropriate level, **d) resolving resource use conflicts** as in the case of compensatory payments from the downstream to the upstream for releasing water through a weir at the time of droughts, **e) reducing environmental stress** by the installation of various water quality improvement facilities, **f) rehabilitation and restoration** of degraded riparian ecosystems, **g) resource value protection** as in the case of zoning for reed bed protection, **h) precautionary actions** as in the case of refraining from undertaking a large-scale structural intervention project that may irreversibly alter the lake's flow regime, and

i) overall ecosystem maintenance that would be related in some ways to many of the above plans.

The plans developed for the various reasons and purposes, however, may not necessarily produce the desired outcomes, typically because of a lack of harmony regarding their timing or scale. The resource development and resource conservation plans individually introduced, for example, could result in a conflicting outcome. The temporal and spatial scopes of plans can prove inconsistent with the manner in which a lake ecosystem responds, despite significant financial, technological and manpower investments. The improvement of lake water quality, for example, could prove to be a very erratic goal over the short time horizon of planning.

In summary, there is a need for more than planning and implementation activities alone to ensure inconsistencies among individual reasons and purposes would gradually be harmonized. The individual plans would complement each other over time, with the overall outcome of these plans being consistent with sustainable development, use and conservation of lake basin resources. This suggested approach defines the Platform Process of ILBM, a concept described in the following section.

Six Pillars of Governance

The adequacies and inadequacies of lake basin management for individual lake basins may be determined by reviewing and assessing the existing management activities and practices. Based on the comprehensive surveys of the state of world's lakes conducted over the past decades, relevant review questions have been categorized into six thematic domains, including: **(1) Institutions** to manage a lake and its basin for the benefit of all lake basin resource users, **(2) Policies** to govern people's use of lake resources, and its impacts on lakes, **(3) Involvement of people** to facilitate all aspects of lake basin management, **(4) Technological possibilities and limitations** that often dictate long-term decisions, **(5) Knowledge** of both traditional and modern scientific origin as the basis for informed decisions, and **(6) Sustainable finances** to support implementation of all of the above-

noted activities. Relevant questions regarding these domains are described in detail in another document. (ILBM PfP document and Guidelines for Lake Brief Preparation).

These six major topics comprise the essential

governance ingredients that collectively form the management regime for the integrated approach for lake basin management encompassed within Integrated Lake Basin Management (ILBM), referred to hereafter as the Six Pillars of Governance in ILBM (**Figure 1**).

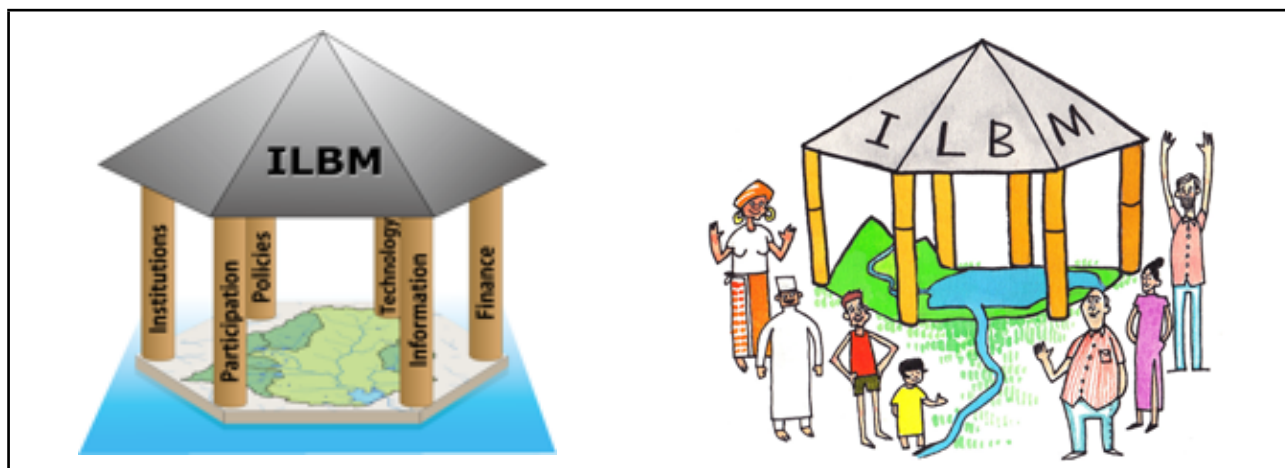


Figure 1: Conceptual Illustrations of ILBM Platform Structure with Six Pillars of Governance

Lake Brief and ILBM Platform Process

Preparation of a Lake Brief

The ILBM Platform Process begins with the preparation of a 'Lake Brief' (**Box 1**). In a practical sense, preparation of the essential part of a Lake Brief may be facilitated by first identifying the 'Impact Stories,' or the past incidents of success and failure, the management implications surrounding the unique physico-chemical characteristics, limitations and prospects facing the basin community, etc., that feature the lake basin environment and its community (**Section IV**). The remaining sections can then be developed around these elements, particularly with regard to the issues and challenges to be described (**Sections V and IV**). Useful inputs, in the form of reviews and suggested refinements, can be obtained effectively through an iterative process by such means as collaborative workshops. Inclusion of appropriate figures, tables, illustrations, maps and other visual materials will obviously increase the usefulness of a Lake Brief. A guideline document is available for preparing a Lake Brief, which contain questionnaire elements that include the biogeophysical features of a lake basin, its socio-economic and governance features, and

Box 1. General Outline: A Lake Brief

The general structure of a Lake Brief is as follows:

1. Introduction
2. Description of the Lake (supplemented by Annex A below)
3. Management of the Lake and Its Basin
4. Major "Impact Stories" of the Lake
5. Major Lake Basin Governance Issues (supplemented by Annex B below)
6. Key Challenges to Lake Governance (supplemented by Annex B below)
7. References

Annex A. Lake Questionnaire

Annex B. Six Pillars of Governance

impairments to its sustainable use, including its ecosystem regulating services (Nakamura and Rast, 2012)

This Lake Brief forms a knowledgebase for the ILBM Platform Process discussed earlier, and which conceptually transforms the existing state of lake basin governance exhibiting very weak or non-existent governance pillars into a sounder state after exerting effort for governance improvement by strengthening of the Six Pillars of Governance, as shown in Figure 2.

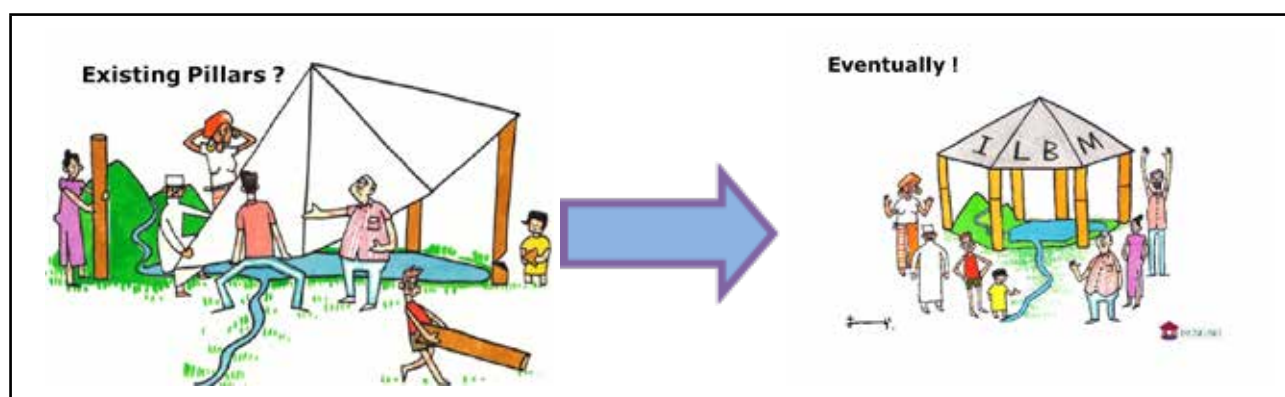


Figure 2: Strengthening Six Pillars of Governance for the ILBM Platform Structure

Development of ILBM Platform Process

In general, the ILBM Platform Process takes the form of a cyclic process (Figure 3). While the conventional approach in planning for lake basin management is primarily a government-driven activity, thereby often exhibiting a very 'top-down,' as well as 'expert-driven,' management

approach, the ILBM Platform Process deprives a broad range of stakeholders, despite the fact that they are usually the ones most affected by the implementation of such plans. The usefulness of a cyclic process will become apparent over time, with the collective aspiration to improve the basin governance over time.

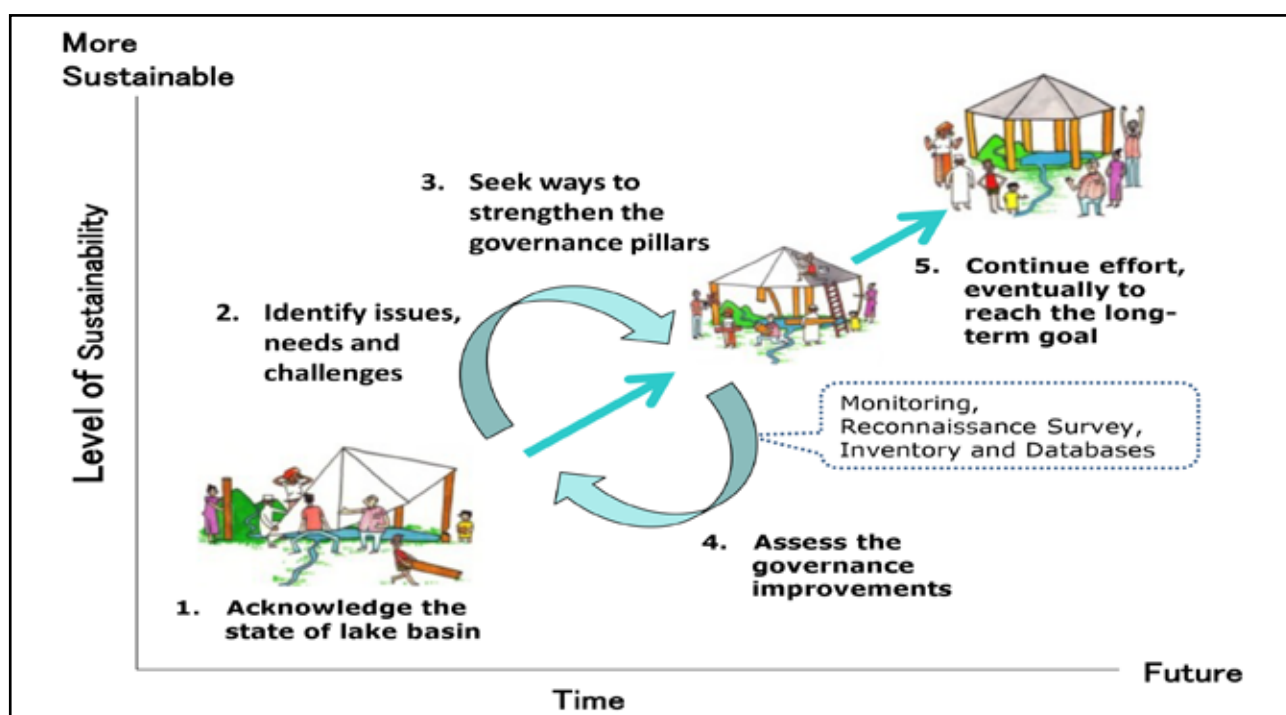


Figure 3: Conceptual Image of a Cyclic ILBM Platform Process

Figure 4 is a diagrammatic presentation of the Cyclic ILBM Platform Process. It begins with **Step 1**), "Description of the State of Lake Basin Management," for which the information and data gained in preparing the Lake Brief for a given lake and its basin play a key role. The analysis of "Issues," "Needs," and "Challenges" regarding the Six ILBM Governance Pillars identified in

Sections V and VI of the Lake Brief will take place in **Step 2**) of the Platform Process. For **Step 3**) of the Platform Process, the stakeholders should be ready to discuss and consider how the "Challenges" identified above in **Step 2**) may be addressed. This step generally requires collective, critical self-analysis of the background and reasons why such "Challenges" arose in the first

place, and how they may be most productively addressed. A set of guiding questions, prepared on the basis of the compiled documentations of past lake basin management experiences, may be very useful for this step.

There are two important considerations for assessing incremental improvements in lake basin governance; namely, (1) time intervals for review and assessment; and (2) assessment methodologies and indicators.

The time intervals for review and assessment can vary from a few months to several years in order to observe measurable improvement, depending on the nature of the challenge to be addressed. The assessment methodologies and indicators to be adopted for the Platform Process also can vary widely, depending on the nature of governance improvement challenges. Among the methodologies in the literature, the one proposed here is used for monitoring and assessment of international transboundary environmental projects by the Global Environment Facility (Duda, 2002). This methodology uses two types of “output-oriented” indicators, and one type of “outcome-oriented” indicator. The two “output-oriented” indicators include the “enabling process indicators,” and the “stress reduction indicators,” which enable and set needed actions into motion, while the “outcome-oriented” indicators measure

actual responses in the lake basin to the “output-oriented” actions, as follows:

- a. Examples of “**enabling process indicators**” may include: Realization of stakeholder involvement in the creation of a management plan; enactment of regulations on the mesh size of nets in order to reduce the quantity of inadvertently-harvested juvenile fish, and legal and institutional reforms for harmonization of various environmental management plans,
- b. Examples of “**stress reduction indicators**” may include: Increased reed bed area resulting from de-siltation operations; reduced industrial pollution loading because of more stringent enforcement; reduced excess water withdrawals; reduced agrochemical application per crop land area; reduced silt and sediment carried into the lake;
- c. Examples of “**environmental status indicators**” may include: Decreased nutrient concentrations; improvement in the state of ecosystem health, as reflected in an increased biodiversity index and, utilizing questionnaire surveys, determining the extent to which communities and stakeholders benefitted from the measured changes in environmental conditions.

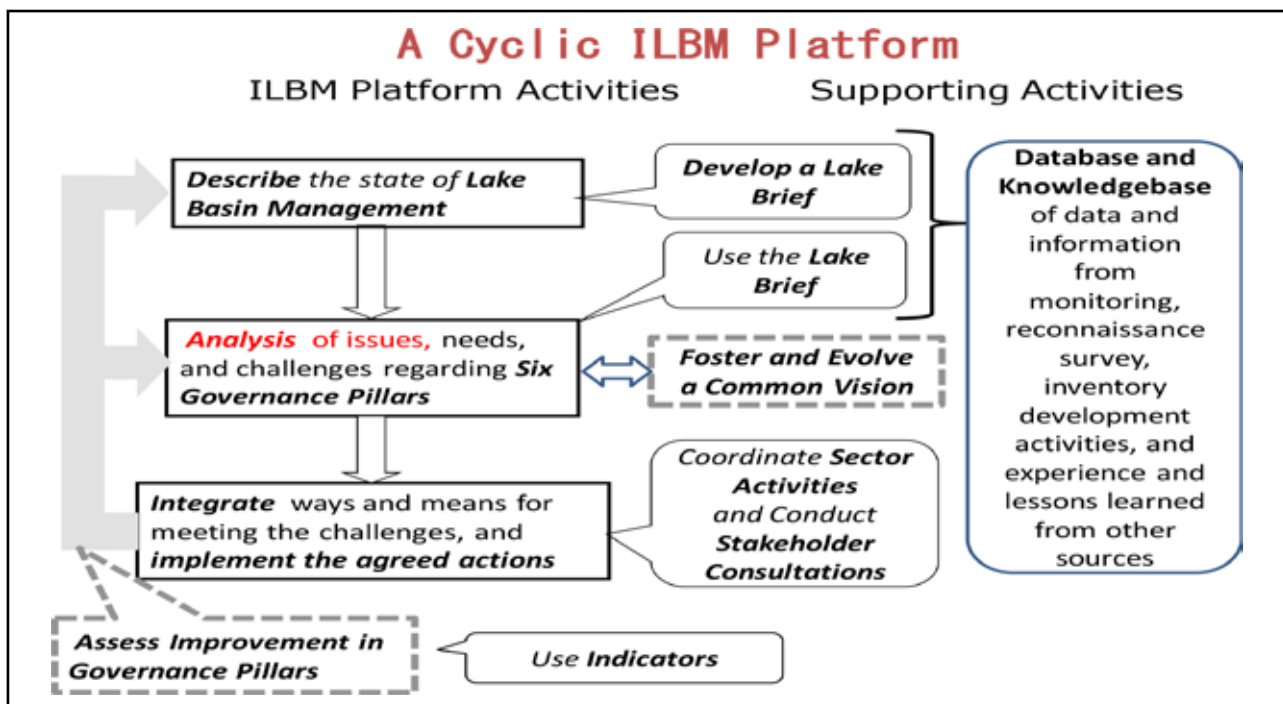


Figure 4: Flow Diagram of Cyclic ILBM Platform Process

It is to be noted that the values and information associated with “stress reduction indicators” and the “enabling process indicators” are easier to obtain, being rather straight forward measures of progress toward improved lake basin governance. In contrast, some of the “environmental status indicator” values are not easy to obtain, and are more difficult to interpret, compared to the other two types of indicators. This is because of the ‘lag period’ that typically occurs after corrective or remedial actions have been undertaken for a lake because of its long water residence time, meaning that some period of time will pass before actual improvements become noticed and/or measurable.

Global ILBM Application Cases

ILBM Training and Technical Cooperation Projects

The efforts to promote the ILBM concept have been steadily strengthened over the past decade particularly through the training of experts dispatched from different national governments to attend the ILBM (2005 through 2015) and ILLBM (from 2016 on) training courses supported by International Lake Environment Committee Foundation (ILEC) and Japan International Cooperation Agency (JICA). There have also been a growing number of application cases reported with different kind of implementation schemes, mostly in the form of multi-year on-site ILBM technical collaboration projects involving local government, scientists, NGO members, citizen groups, etc. They have mostly been supported by different Japanese Government funding programs implemented through Research Center for Sustainability and Environment, Shiga University (RCSE-SU), Japan, and ILEC. Such efforts and application cases cumulated over the period between 2005 through 2016 are summarized in Table 1.

With regard to training of personnel dispatched from developing country governments in need of developing and/or strengthening their lake basin management program, the reach-out has been ubiquitously global. Many local and national policies and programs in lake basin management have been enriched by the knowledge and experience shared by the trainees of past JICA-ILEC training courses upon their return home.

With regard to the ILBM technical collaboration projects, the emphasis has been focused mainly on Asia and part of East Africa, particularly Kenya. The major reasons for focusing on a relatively small number of countries was to make sure such efforts would contribute to the infusion of ILBM concept into the mainstream national policies and programs on water and environment management, such as Integrated Water Resources Management (IWRM) and Integrated River Basin Management (IRBM), if not on lake basin management per se. Such efforts usually constitute many rounds of consultative process over many years, with joint studies, training, field visits and occasional local, national and international meetings for cross-fertilization of experience.

Very significant outcome is being expected with the strategy to combine the ubiquitously global approach for training of experts, with the small number of bilateral and multilateral ILBM technical cooperation projects. For example, as shown in Table 1, the Kenyan Government is undergoing a review process for adoption of the draft national strategic plan for lake basin management prepared by the ILEC-supported Kenyan team consisting of representatives from local governments, NGOs and communities and scientific institutions. For another example, the ILBM framework has been applied to 50 Lakes for conservation and designation of lake-cluster of the Pokhara Valley with collaboration of Ramsar Convention Secretariat for South Asia. NLCDC is to (1) implement the National Lake Conservation and Development Strategy Plan; and, to (2) set up an Ad Hoc Committee for the establishment of the ILBM South Asian Platform. In Malaysia, ILBM is endorsed by the government for the management of lentic systems in Malaysia in 2012, and over the past decade or so, NHARIM has completed lake briefs for most of the 92 lakes currently identified nationally. The National Framework for Action, completed in 2018, states that IRBM and ILBM must be infused for managing river and lake basins that form geographical units with well-defined boundaries containing the sum of all hydrological processes operating within them. The Republic of Indonesia, on the other hand, has been promoting what is called GERANDAM or 'Lake Ecosystems Rescue Movements', a concept

similar to ILBM being adopted to the national development plan for 2015-2019 with 15 priority lakes. Indonesia hosted the 16th World Lake Conference in Bali in November 2016 where the

concept of ILBM was widely disseminated, with some follow-up collaboration with ILEC and Japanese Government.

Table 1: ILBM Application Cases for the Period 2005-2016

Summary of ILBM Application Cases: 2008-2016	
Region	ILBM-related Activities Undertaken
African Region	<ul style="list-style-type: none"> The number of Lake Briefs produced by JICA trainees are 3 for Central, 21 for Eastern, 6 for Northern, 3 for Southern, and 6 for Western Africa. An ILBM Platform Process was developed each for Lakes Baringo, Nakuru, Victoria (Nyanza Bay) by the Kenyan local ILBM teams, with preparation of a lake brief each for Naivasha, Turukana, Jipe and Natron. Teams from many of the above lakes were involved in ILBM-Governance, ILBM-Heartware and ILBM-ESSVA projects supported by RCSE-SU and in part in collaboration with UNEP and LVBC. The Kenyan Government is undergoing a review process for adoption of the draft national strategic plan for lake basin management prepared by the ILEC-supported Kenyan team consisting of representatives from local governments, NGOs, communities and scientific institutions. The sharing of East African experience with West African lake basins has been initiated.

Asian Region	<ul style="list-style-type: none"> The number of Lake Briefs produced by JICA trainees are 1 for Central Asia, 2 for East Asia, 10 for South Asia, 18 for Southeast Asia, and 6 for West Asia, other than those shown below. India: <ul style="list-style-type: none"> Assessment of a JICA-assisted Lake Bhopal project was the first ILBM application case in South Asia. Over the period of 2007 and 2008, an ILBM training has been conducted for 15 trainees from Lake Hussain Sagar Lake, Hyderabad. The experts working on Lake Chilika, State of Odisha, have been applying the ILBM framework for assessing its lake basin governance. The ILBM framework is being applied to scores of Indian urban lake basins, such as those in Pune, Udaipur and Pushkar, Mumbai, by the IAAB affiliated NGO-research scientist teams in collaboration with local governments and the concerned citizen groups, in collaboration with MOEFCC. Indonesia: GERANDAM or 'Lake Ecosystems Rescue Movements', a concept similar to ILBM, was adopted to the National Mid Term Development Plan 2015-19 in which 15 priority lakes have been identified. Indonesia also hosted in November 2016 the 16th World Lake Conference in Bali where the concept of ILBM was widely disseminated, with some follow-up consultative process taking place between the Indonesian Government and the Japanese Government. Nepal: The ILBM framework has been applied to 50 Lakes for conservation and designation of lake-cluster of Pokhara Valley with collaboration of Ramsar Convention Secretariat for South Asia. NLCDC is to (1) implement the National Lake Conservation and Development Strategy Plan; and, to (2) set up an Ad Hoc Committee for the establishment of the ILBM South Asian Platform. Malaysia: ILBM is endorsed by the Malaysian Government for the management of lentic systems in Malaysia in 2012, and over the past decade or so, NHARIM has completed lake briefs, an essential component of the ILBM process, for most of the 92 lakes. The National Framework for Action, completed in 2018, states that IRBM and ILBM are needed for managing river and lake basins that form geographical units with well-defined boundaries containing the sum of all hydrological processes operating within them, and transcending political and administrative constraints, making them ideal water management units to address water problems. Philippines: Many ILBM related programs have been implemented informally by ILEC in collaboration with LLDA for enhancing the national program for lake basin management in the Philippines. Of particular importance is the joint effort to promote ILBM to other lake basins particularly within the jurisdiction of LLDA. The ILBM framework has also been promoted for addressing sustainable resource management of Lake Lanao and its basin in the State of Mindanao, an ancient global-asset lake currently facing many contentious management challenges.
Russia	<ul style="list-style-type: none"> A Lake Brief has been prepared for each of the three lakes in the northwestern part of Russia, by the National Institute of Limnology, Saint Petersburg, and preliminary efforts have been undertaken to prepare a Lake Brief for the Caspian Sea and Aral Sea.
Middle East, Balkan Region	<ul style="list-style-type: none"> The number of Lake Briefs produced by JICA trainees are 6 in this region other than those shown below. A project entitled, "Marsh Preservation in Iraq by JICA" was implemented between 2005 and 2010, accommodating 62 participants to the program. A special ILBM training was implemented for Iran in 2014, attended by 5 participants. There is growing interest in ILBM expressed by the countries in this region.

Central America, Caribbean	<ul style="list-style-type: none"> The number of Lake Briefs produced by JICA trainees are 6 for Mexico and 5 for Guatemala. Mexico: Development of an ILBM Platform in the Lake Chapala and Lerma River basin micro-watershed regions over a period of 2009-2012, particularly with regard to the stakeholder initiative, through horizontal (through regional networks), as well as vertical (national, state, and local linkages), collaboration for accelerating the ILBM Platform Process.
South America	<ul style="list-style-type: none"> The number of Lake Briefs produced by JICA trainees are 4 for Argentina, 9 for Brazil, 4 for Chili, 1 for Colombia, 1 for Paraguay and 1 for Uruguay. ILEC is intending to strengthen involvement in promoting ILBM in South America over the next decade.

GERMADAN: Gerakan Penyelamatan Danau (Save Indonesian Lake Movement); **ILBM-ESSVA:**

ESSVA stands for Ecosystem Service Shared Value Assessment, a methodology for assessment of the magnitude of the ecosystem service measured by a combination of perceptual profile and factual profile under development by ILEC. **ILBM-HEARTWRE:** Heartware is a term used to express the intrinsic value to be integrated into the ILBM platform process that tends to be dictated more by software (policy, institution, participation and science) and hardware (technology and funding) components than intrinsic elements. **JICA:** Japan International Cooperation Agency; **IAAB:** Indian Association of Aquatic Biologists; **ILEC:** International Lake Environment Committee, Japan; **LVBC:** Lake Victoria Basin Commission; **LLDA:** Laguna Lake Development Authority; **MOEFCC:** Ministry of Environment, Forestry and Climate Change, India; **NHARHIM:** National Hydraulic Research Institute of Malaysia; **NLCDC:** National Lake Conservation Development Committee, Nepal.

Stages of ILBM Platform Development

It is emphasized that the development of an ILBM Platform Process is not a stand-alone, one-time project, but rather a long-term governance challenge to be met by the entire lake basin society and stakeholders. Once initiated, the process must evolve and be sustained over coming decades and, over the course of time, the process will have to become owned by the basin community at large, hopefully by being integrated into a local/national statutory framework. Figure 5 provides a schematic example of such a long-term process, in which the timeframe is divided into four phases; Phase I is a Preparatory Phase, Phase II is a Getting Started Period, Phase III is a Trial-and-Error Period, and Phase IV is a

Sustainability Challenge Phase. In addition to being a governance improvement process by itself, the Cyclic Process during Phase II and Phase III should also be able to guide the process of planning and implementing various public and private sector management intervention projects. Introduction of a sewerage system, for example, would have to be well integrated into the ILBM Platform Process to facilitate the sustainability of its construction, management and operation. For already-existing management intervention programs, the Platform Process should be able to provide an informative retrospective, as well as prospective assessment to help adjust the course of preparation toward the future with a more coherent and concerted approach to governance improvement. With such a broad range of reasons/purposes, the management of lakes and their basins is approached within ILBM within the corresponding range of sectoral activities, with or without formal plans. The type and the nature of such comprehensive management plans also vary widely, depending on the existing national statutory and policy frameworks in the case of many developed countries, and on the contractual framework in the case of bilateral and multilateral technical collaboration involving developing countries.

While the aim of ILBM is to attain long-term sustainability of lake basin resources and their use, the experience to date suggests that, in many parts of the world, the magnitude, as well as the rate, of lake basin resource degradation is enormous and continuing. There are some fundamental challenges in managing lakes and their basins, regardless of ILBM applications. Although the emerged typology pertains to the way ILBM may help achieve the sustainability

of lake basin resources and their use, it is not designed to attain sustainability itself. Attainment of sustainable use of any ecosystem has been, and will continue to be, a long-term global challenge

that must be integrated as a mainstream issue facing the international community.

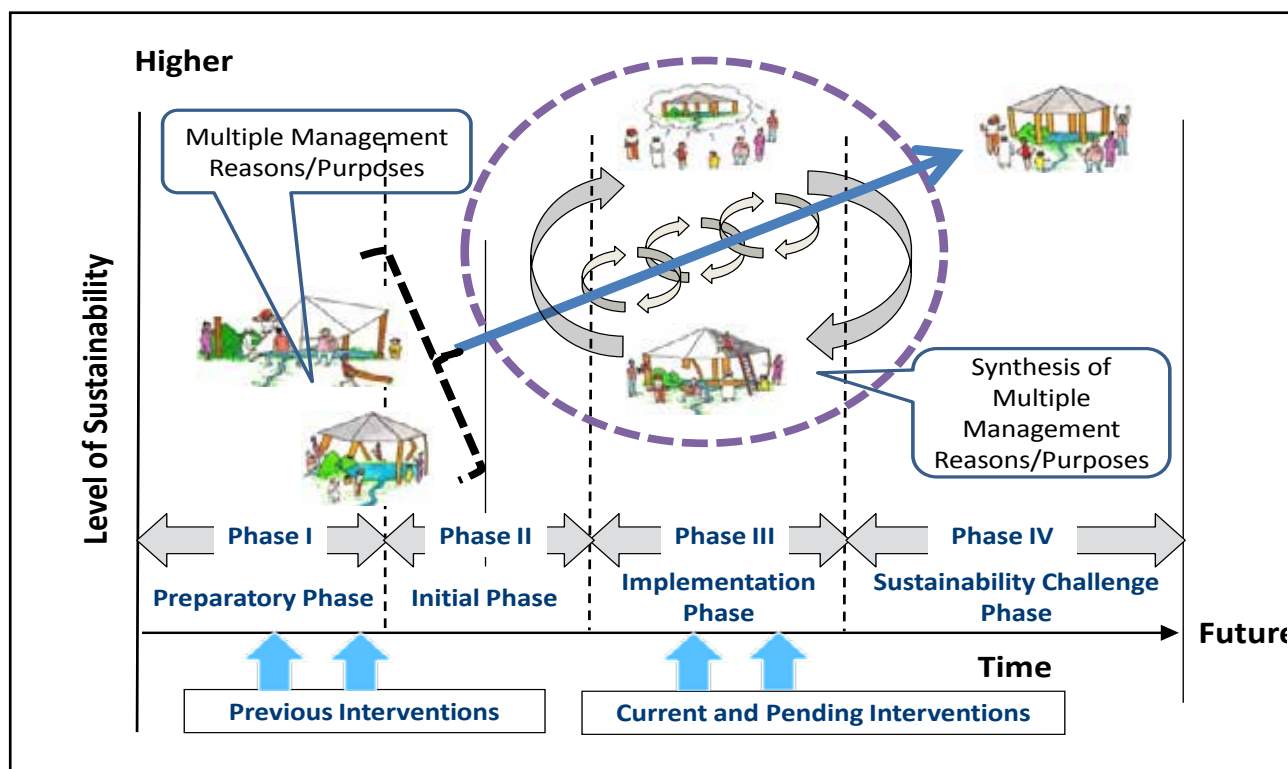


Figure 5: ILBM Platform Process in Stages, with Gradual Synthesis of Management Reasons/Purposes

Knowledge Base and Data Base Systems

An enormous quantity of information and data has been generated so far, and will continue to be generated, on a wide range of thematic subjects pertaining to lake basin management, on both a national and international basis. Much of it pertains to natural science topics, including physical, chemical and biological aspects (limnology, hydrology, climatology, ecology, biochemistry and others), all of which contribute to a better understanding of the state of lakes, reservoirs and other lentic water bodies. There is also a growing number of studies on the managerial aspects of aquatic, terrestrial and riparian ecosystems, including water quality, sediment quality, and shoreline environments, together with the inflowing and outflowing water systems, extending out to the upper watershed tributaries. A needed component not yet produced, however, is a means of compiling and utilizing holistically- and practically-synthesized information on such thematic and

disciplinary subjects. Focusing both on the compilation of global experiences and lessons learned in managing lakes and their basins, for example, a detailed account of the Six ILBM Governance Pillars is provided in the document, "Managing Lakes and their Basins for Sustainable Use: A Report for Lake Basin Managers and Stakeholders," (ILEC, 2005), which is available on the website: (<http://www.ilec.or.jp/eg/lbmi/index.html>). An electronic training module of this document also is available on the website: (<http://wldb.ilec.or.jp/ILBMTrainingMaterials/index.html>). This document has played an instrumental role in the conceptualization process of ILBM, and now that the number of such efforts is growing, developing and sharing the knowledge being continually generated and accumulated is even more important. An interactive knowledge base-cum-knowledge mining system, called LAKES (Learning Acceleration and Knowledge Enhancement System) has been developed to address this goal. LAKES currently has the capacity to process hundreds of documents for

the purpose of ‘mining’ the imbedded knowledge with the use of free keywords or an included thesaurus, ranging from the level of whole documents, down to pages, paragraphs, and even individual sentences. Although a database system called the World Lake Database that was constructed to reflect the output of Survey of the State of World Lakes (1986-1988), the content of which is currently being updated, it is expected that the data and information compiled in the form of technical writings such as Lake Briefs and the journal publications on lake basin management will continue to grow. The use of a knowledgebase system, not only for mining the text-based informational resources but also for mining the numerical and graphical informational resources, would become quite important. The use of LAKES therefore may well compliment the conventional form of database systems such as World Lake Database.

Summary and Way Forward

On a global scale, the terrestrial and sub-terrestrial land constituting the basins of rivers and their sub-surface flows, lakes, estuaries, lagoons and marshlands and other enclosed and semi-enclosed water bodies, have undergone tremendous transformations over the past centuries, with the rate of transformation even increasing over the past several decades. The impacts of this transformation, in the form of environmental pollution and ecosystem degradation, have transcended far and wide to receptor water systems as well, including aquifers, marine ecosystems and the oceans. Despite all the efforts undertaken thus far to mitigate and restore these water systems, this global trend is far from being reversed. As a consequence of this reality, the lentic (naturally non-flowing, with historically fostered ecosystem and anthropological implications, in contrast to simply being hydrostatic) parts of these linked water systems, have been seriously impacted, hindering the sustainable use of their resource values. In fact, the pursuit toward environmental and ecosystem sustainability of lentic water systems is very different from that of lotic systems. Thus, managing linked water systems with imbedded lentic properties requires an approach that recognizes and takes into account

their unique physico-chemical and biological features, including their integrating nature, long water retention time, and complex response dynamics.

As a further consideration, management of linked water systems with imbedded lentic properties also must consider policy orientations amenable to their resource-use governance. This is because lake basin resources typically exhibit the feature of being “common property” in their existence and use. This means resource users must practice self-restraint in their pursuit of the resource values of lakes if they wish them to be sustainable. The suitable institutional form to achieve this long-term goal, however, may emerge only after a long, gradual and adaptive process of collective adjustments. This is in contrast to the reality of the resource development sectors often being hesitant to allocate their funds and manpower for purposes other than meeting their own much longer-term resource requirements. It is difficult, therefore, if not impossible, to prescribe a management framework that is universally workable for water systems with imbedded lentic system properties. Herein lies the underlying reason for the need to conceptualize an approach to help lake basin stakeholders manage lentic water systems for sustainable use through gradual, continuous and holistic improvement of basin governance. Indeed, if we have learned anything from managing lentic water systems to date, it is that their management is a continuing process requiring adaptation to changing conditions, rather than a one-time, stand-alone project.

No United Nations initiative has yet been put forth to mainstream “lakes” within the global water agenda, despite the fact its many UN documents highlight the ‘importance’ of IWRM. This is not to say that IWRM is not important, but rather that global experiences to date indicate, it cannot adequately address the assessment and management challenges of lentic water systems, or the complexities and management implications of linked lentic-lotic water systems. Thus, it is now time to recognize that ILBM must be promoted to deal with linked water systems of a lentic-lotic nature, focusing on their governance improvement at alocal, national, sub-continental, continental and international level.

References

- Duda, A., 2002. *Monitoring and Evaluation Indicators for GEF International Waters Projects*, Monitoring and Evaluation Working Paper 10, World Bank, Washington, D.C. 11p.
- ILEC. 2005. *Managing Lakes and Their Basins for Sustainable Use: A Report for Lake Basin Managers and Stakeholders*. International Lake Environment Committee Foundation (ILEC), Kusatsu, Japan. 146p.
- Millennium Ecosystem Assessment. 2005. *Synthesis Reports: Ecosystems and Human Well-being: General Synthesis*, downloadable from [http://www.maweb.org/documents/document.356.aspx x.pdf](http://www.maweb.org/documents/document.356.aspx.pdf) Ecosystems and human well-being: current state and trends : findings of the Condition and Trends Working Group / edited by Rashid Hassan, Robert Scholes, Neville Ash. <http://www.maweb.org/documents/document.765.aspx x.pdf>
- Nakamura, M. and W. Rast 2011. *Development of ILBM Platform Process: Evolving Guidelines through Participatory Improvement, 1st Printing*. Research Center for Sustainability and Environment, Shiga University and International Lake Environment Committee Foundation (ILEC), Kusatsu, Japan. 76p.
- Nakamura, M. and W. Rast 2012. *Guidelines for Lake Brief Preparation*. Research Center for Sustainability and Environment, Shiga University(RCSE-SU), Otsu and Hikone, Japan, and International Lake Environment Committee Foundation (ILEC), Kusatsu, Japan. 17p.
- Nakamura, M. and W. Rast 2014. *Development of ILBM Platform Process: Evolving Guidelines through Participatory Improvement, 2nd Edition*. Research Center for Sustainability and Environment, Shiga University and International Lake Environment Committee Foundation (ILEC), Kusatsu, Japan. 76p.
- Nakamura, M. and W. Rast, 2016. *Promoting integrated lake basin management (ILBM): the initial global experience, 2008-2012*, in “Enhancing Water Management Capacity in a Changing World: Science: Academies Working Together to Increase Global Access to Water and Sanitation(PP166-201)” (Editors: F. R. Spilki, M. C. B. Scheuenstuhl, J. G. Tundusi), Associação Pró-Ensino Superior em Novo Hamburgo – ASPEUR, Universidade Feevale 710 P.

Chapter 2:

Experiences from

Southeast Asia

Sustainable Management of Water Bodies for Rural Livelihood Development- A Case Study in Sri Lanka

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Abstract

Sustainable livelihood approach is used to understand the current condition of two mangrove-based farmers in two districts in southern Sri Lanka. We observed the five livelihood capitals, identified as natural, social, human, financial and physical used in sustainable livelihood approach. To get wider and clear understanding on these capitals, effect on livelihoods of these two villagers were examined. These households in the two villagers were categorized according to their farm size. Majority of the farmers were engaged in agricultural activities whereas others were not cultivating their lands. Fishing/shrimp collection, ecotourism, getting salary from government and private organizations are their main livelihood sources. Results reveal that it is very important to consider all five livelihood capitals in these two villagers to manage mangrove-based water bodies in a sustainable way.

Introduction

Rural poverty has been accepted as both a major cause and result of degraded soils, vegetation, forests, water and natural habitats. Although poor people in developing countries are particularly

dependent on natural resources and its ecosystem services for their livelihoods, they live in areas of high ecological vulnerability and relatively low levels of resource productivity (Semasinghe, 2015). Mangrove ecosystem provides habitat for a variety of species of birds, mammals, reptiles, fish, crustaceans and molluscs. And also, it protects shorelines from erosion and reduces impacts from storms surges and Tsunamis (Jonsson, 2017). Rapid deforestation and biodiversity losses are depriving people of valuable mangrove-based water resources, such as fuel wood, fish, shrimp, food, medicine, ecosystem-based services such as bird watching, boat riding. Water pollution and degradation of mangrove-based ecosystem is a major threat to the livelihoods of number of people who live in and around of these areas, mostly the poor. Considering such linkage between nature resource degradation and poverty, understanding the livelihood of poor living in degraded environment is vital for designing sustainable resource management.

The Sustainable Livelihoods Approach (SLA) emerged partly as a result of this rethinking of poverty-environment linkages and has since become a driving force in its evolution. One of the key attributes of SLA is the livelihood capital of

household as capital serve as vehicles for making a living, making living meaningful and challenging the structures under which one makes a living. The livelihood framework identifies five core capitals which sometimes are called livelihood building blocks upon which livelihoods are built.

These are natural capital, social capital, human capital, physical capital and financial capital (Figure 1). Natural capital is the natural resource stocks including plants, trees, soil, water, land with its characteristics and so on. while financial capital refers to monetary capital bases such as

incomes, savings and other. The skills, knowledge, ability to labour and others are the human capital. Physical capital includes productive assets held by the households like vehicles, tools and at community or citizen level, harbours, road networks, hospital, schools etc. The social capital includes networks, social claim, social relations, affiliations, association upon which people draw when pursuing different livelihood strategies requiring individual or coordinated action (Allison and Ellis, 2001, Allison and Horemans, 2006).

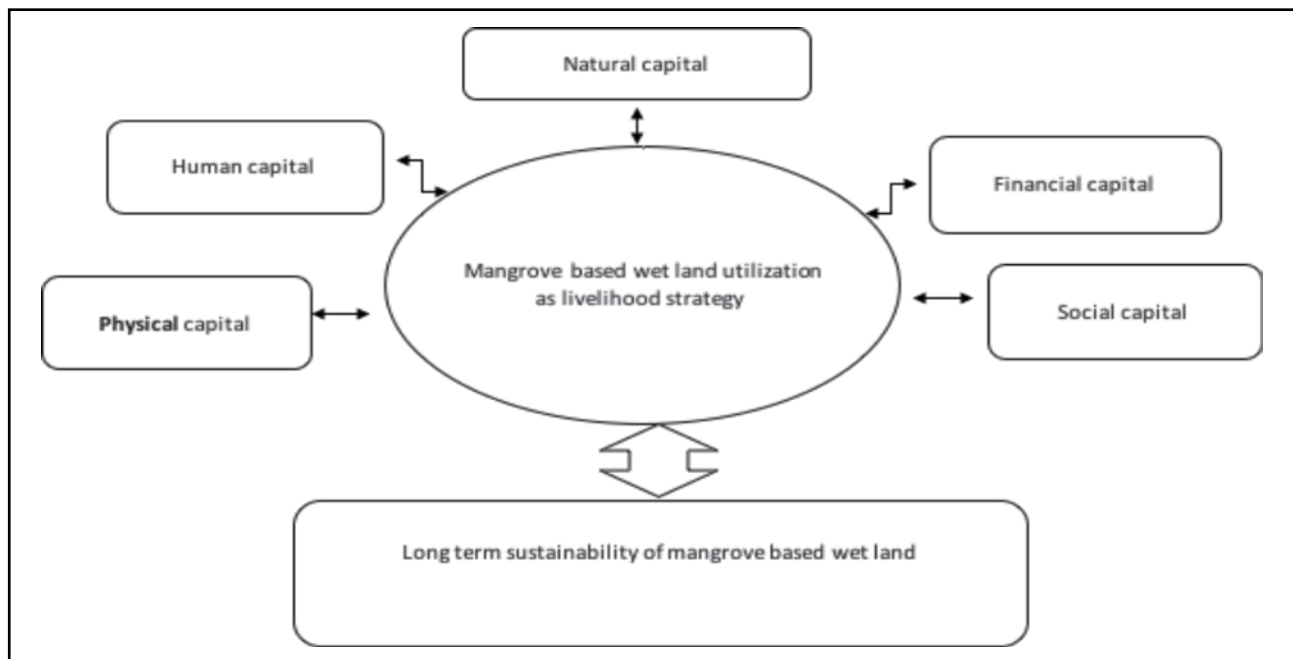


Figure 1: Analytical framework of the study

Improving capital assets is a primary strategy for improving rural people's livelihood from a given livelihoods strategy. The rural poor usually require a range of capitals to pursue their strategies. Mangrove-based water bodies in Sri Lanka are covered by 22534 ha in 1992 and 18352 ha in 1996 with an annual change of -5% (ha -1046) and, according to Coastal Conservation and Coastal Resource Management Department it was 8718 ha in 2014 (Jonsson, 2017)

Such understanding enables framing of strategic questions for development planning such as increase in one capital such as land can substitute for a lack of financial capital in particular livelihood strategy or do people need to change the whole livelihood strategy in order to efficiently utilize the available capitals and do those who escape from poverty start with a particular combination of capital assets.

Method

The study is conducted in Matara and Hambantota districts which represent lowland wet and dry agro-ecological zones of the country respectively. After preliminary discussion with stakeholders (forestry & wildlife officers and settlers in and around the mangrove based wetland) were selected for the study as they have highly depend on these wet water bodies for their day to day livelihood activities.

Data collection was conducted in two stages. In the first stage, review of archival records such as field records as well as reconnaissance survey of the research site together with government officers in charge of the area after consultation with a total 50 householders from Matara (25) and from Hambantota (25) were randomly selected for data collection based on five livelihood

capitals and their present land size available to them (Figure 1). Results were analysed with R statistical software and some were presented / compared as percentage values.

Results

In Matara, large proportion of the randomly sampled households belongs to the Very Small Livelihoods (VSLH) category which has an average land area of 0.7 ha and was highly dependent on fishing rather than on other

extraction from the mangrove-based water resources. In Hambantota district VSLH category farmers were highly dependent on catching shrimps than other extractions (Table 1).

Another important capital for the growers is mangrove trees. And it provides cheap source of firewood to meet energy requirements, timber and nutrients for the householders for the both districts and both usages were significantly higher in Hambantota district.

Table 1: Natural and bio- physical capital of respondents in the two districts

Natural & bio-physical capital	Matara District				Hambantota District			
	VSLH	SLH	MLH	LLH	VSLH	SLH	MLH	LLH
Farm size (ha)	0.7	1.3	2.4	3.7	0.8	1.3	2.1	5.9
%Uncultivated	11	22	13	22	15	6	7	30
Extractions	F/FW/S	F/FW	F	F/S	S/FW/F	F/S	S	S

Note: VSLH = Vey Small Livelihood Household, SLH= Small Livelihood Household, (2) MSV= Medium Livelihood Household, (3) LLH = Large Livelihood Household

Financial capital of the farmers was measured by income from four major sources such as fishing, agriculture, eco- tourism, and labor work (Figure 2). For effective management of the water body, human capital of the household such as experience in fishing/ shrimp catching and formal training by the government and NGO was considered. In both cases Hambantota households got the higher number of trainings. Social capital such as fishing society was found in both districts but householders were not fully satisfied with their role for the betterment of the mangrove-based ecosystem (Figure 4). Availability and mode of transportation in the rural farming areas plays key role in rural economy. Hence, analysis of

physical capital involved assessment of possession of different transportation means. Different type of vehicles, including bicycles, motor bicycles, three-wheelers, tractors, trucks and cars were possessed by the farmers, but neither of them used animal-drafted vehicles. Bicycles and motor bicycles were common among all. Jeep usage is extremely luxurious where Hambantota has the higher value. Owing to the less productivity and profitability and long-term sustainability of the system it is highly essential to educate the householders to protect the mangrove based water bodies while creating livelihood opportunities for them to improve their life style.

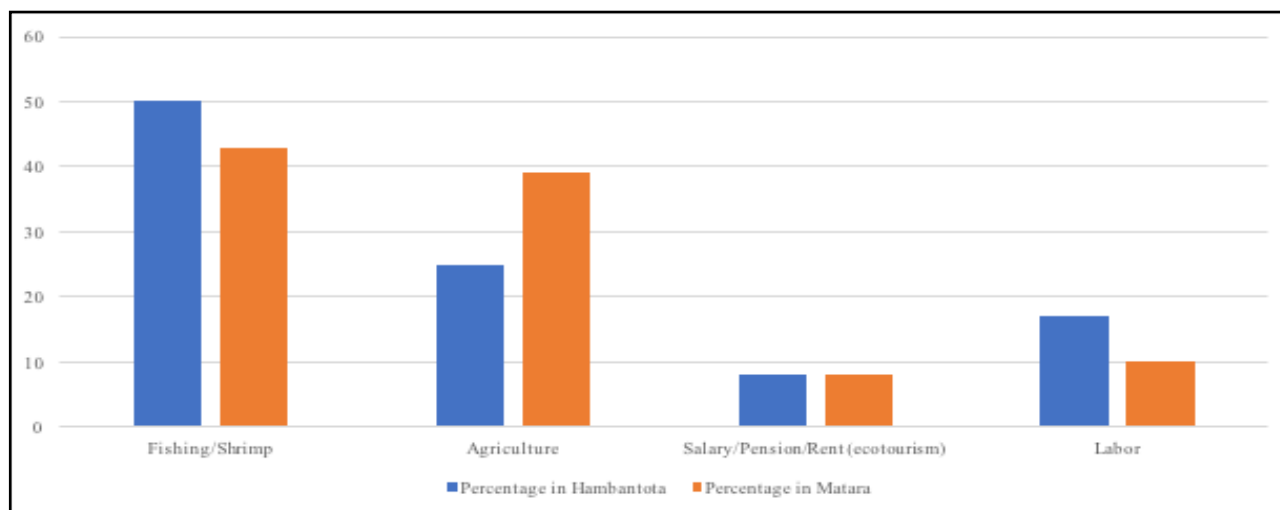


Figure 2: Financial capital Distribution (measured by income from four major sources)

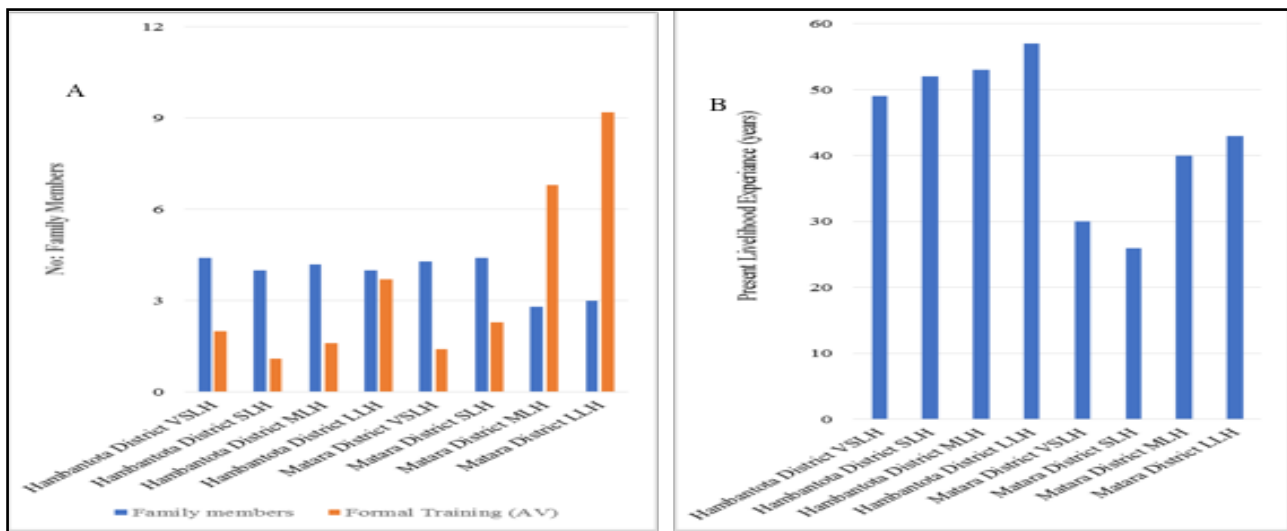


Figure 3: Human capital Distribution

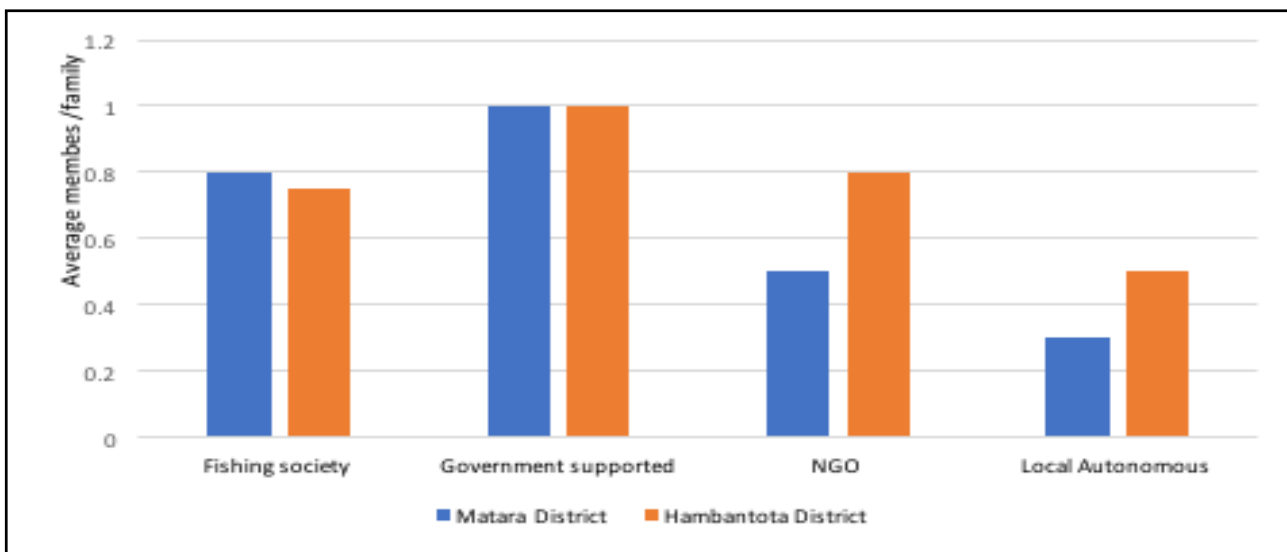


Figure 4: Social Capital Distribution

Majority of the farmers in both districts were attached to the government supported welfare scheme (common poverty alleviation programmes) than fishing related supporting societies mainly due to wish to get better/higher benefits from the government. Local autonomous societies especially control over the harvesting of fish (especially in the breeding season) and over-exploitation of the mangrove tree species used as timber/fuelwood by the villagers.

Conclusion

Farmers in both study sites have utilized five livelihood capitals not in an effective way. Therefore government involvement is much needed to improve villagers' livelihood while protecting the mangrove-based waterbodies in the study area.

Reference

- Allison, E. H. & Ellis, F. 2001. The livelihoods approach and management of small-scale fisheries. *Marine policy*, 25, 377-388.
- Allison, E. H. & Horemans, B. 2006. Putting the principles of the sustainable livelihoods approach into fisheries development policy and practice. *Marine policy*, 30, 757-766.
- Jonsson, M. 2017. Social-Ecological Resilience of Mangroves and Coastal Households in Batticaloa District, Sri Lanka. MSc, Norwegian University of Life Sciences.
- Semasinghe, W. 2015. Dimensions of Rural Poverty in Sri Lanka: An attempt to identify the crucial aspects of well-being of rural poor.

Measures in Climate Change Impact in Lakes of Haor Basin in Bangladesh

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Abstract

Bangladesh has different types of lakes. The Haor is a form of a backswamp in a bowl-shaped shallow depression found in the north-east part of Bangladesh. Because of impact of climate change, the resulted hazards, economy and local livelihood patterns have made the Haor basin, the second most vulnerable ecosystem after the coast in Bangladesh. The people of Haor receive their livelihoods from wetland and floodplain resources such as fish, swamp forest, reeds, aquatic fruits and wildlife. Geography of the Haor usually restricts its dwellers for full-time employment. After harvesting rice most of the people in Haor areas become jobless. During the monsoon, the whole area goes under water and there is no option in engaging them in earning activities except fishing. Due to climate change, the rainfall pattern of the basin has changed and first flash flood occurs around two weeks earlier than a decade ago. The Haor is subject to deep monsoon flooding which supports rich fisheries while the drier winter yields a bumper rice crop. While flooding enhances floodplain fisheries, the early flashfloods, unique to this region, caused by the sudden onrush of rainwater from adjacent Indian Hills poses a high risk of damage to the standing winter rice crop. Over years, flash flood

has remained the major climate risks to thousands of rice farmers in the region. Data reveal that rainfall in Meghalaya has increased in March and April that intensifies the severity of flash flood. Constructing dykes to delay or divert the entry of flash flood water into the crop fields is the only adaptation response taken from the government. There are incidents of failure of dykes almost every year and the consequent losses of winter rice. The major constraints of Haor are (1) degradation of natural resources and biodiversity, (2) a lack of availability of basic infrastructure and social amenities, inequity in resource acquisition and poor access to natural resources, (3) crop damage by flash flood, (4) declining productivity of crops, (5) poor market linkage and value addition. Climate change has added complexity to all these constraints. The community is diversifying the cropping pattern as an option of adaptation in the Haor. Building resilience into both human and ecological systems is the best possible way to deal with climate change risk. The capacity to climate change response and social acceptance build social and ecological resilience. Response capacity of a community is the scale of action that promotes adaptive capacity. The cross-sectoral multi-scale stakeholder engagement of the actors who influence or who are affected by the complex

human-ecosystem interactions is the way towards building the social acceptance in an ecosystem. The emerging scope of livelihood diversification in a changing environment and the sustainable management of the resources promote the resilience of the natural systems; application of adaptive ecosystem management evolves through learning-based integrated resource management. The master plan strategy for development of the Haor region includes (1) improved water and disaster management, (2) agricultural development for food security, (3) biodiversity enhancement and wetland management, (4) social safety nets and improvement of living, (5) improved physical infrastructure, and (6) enterprise and technology development, that results towards adaptation to climate change. The paper is based on the observation of climate change impact and coping practices adopted by the community and strategy by the Government. The observation was made in the Haors of Moulvi Bazar and Sunamgunj Districts in the year 2017.

Introduction

The foothill of Meghalaya in Bangladesh is called Haor. The Haor is a special type of ecosystem which is functionally a crop land in winter but wetland for around six months in monsoon. The Haor is bowl shaped shallow depression. It is a mosaic of wetland habitats. The Haor basin in Bangladesh is bounded by the hill ranges of Meghalaya (India), on the north, Tripura and Mizoram on the south, and Assam and Manipur

on the east. The basin extends north to the foothills of the Garo and Khasia Hills, and east along the upper Surma Valley to the Indian border. The people of the Haor receive their livelihoods from wetland and floodplain resources such as fish, swamp forest, reeds, aquatic fruits and wildlife. Nature of the Haor geography usually restricts its dwellers for full-time employment. After harvesting rice most of the people of the Haor area become jobless. During monsoon the whole area goes under water and there is no option to engage local communities in earning activities except fishing. The rainfall pattern of the basin has changed, and the first flash flood is around two weeks earlier than the last decade. There were 4 climate change consultations with the communities of Tanguar Haor and Hakaluki Haor to understand the climate change impact and people's perception towards the coping of the climate challenges.

Impact of Climate Change on Haor Agriculture

The frequency of all types of flooding has been increasing in the Haor basin due to climate change, viz., flash floods, river floods and rainwater floods. The flash flood in the Haor is earlier as compared to the last two decades. Earlier it was from the end of April to mid of May, but now it is happening in mid-April (Table 1). Flash floods cause extensive damages to crop and property in the Haor areas. Early floods generally cause severe damages.

Table 1: Flash Flood Damage of Rice in Haors of Sunamgunj District

Year	Flood water entered the <i>Haor</i>	Inundating the <i>boro</i> Crops	Extent of Damage	Damaged <i>boro</i> Crop in Ha.	Cost of Damaged Crops in Lakh (Taka)
1996	16 March	18 March	75%	29,822	4,102.07
1997	22 May	24 May	15%	9,830	1,278.84
1998	20 May	23 May	40%	11,579	2,365.02
1999	03 May	06 May	45%	10,950	976.65
2000	28 April	30 April	70%	1,355	420.14
2001	27 April	30 April	75%	4,963	1,899.95
2002	14 April	18 April	70 %	21,677	7,058.16
2003	27 May	30 May	20%	20,997	8,666.87
2004	13 April	15 April	90 %	95,402	34,860.40
2005	22 May	25 May	15%	-	-

Earlier the interval between two major floods was around 10 years, but currently it has shortened to 2-3 years. There are examples of two-spells of flood in a year. In 2007, there were two-spells

damaging the rice for the whole seedling season. The flooding status of the Jadukanta river in 2007 is given in figure 1.



Figure 1: River Gauge Level (m) of Jadukanta River For 2007

Climate change has adverse impacts in the Haor basin on agriculture, fisheries, water, human health, and communication. The major impacts

identified from community consultation is given in table 2.

Table 2: Climate Change Impact on Livelihoods in the Haors of Moulvi Bazar

Livelihood	Climate Change Impact
Agriculture	Late Rainy Season
	Hail Storm
	Flash Flood
	Sandy Silt
	Drought
Fisheries	Light Rainy Season
	Flooding
	Heavy Rainy Days
	Cloudy Days
Petty Traders	Flooding
	Drought
Livelihood	Climate Change Vulnerability

The study also found that the major constraints of the Haor are (1) degradation of natural resources and biodiversity, (2) a lack of availability of basic infrastructure and social amenities, inequity in resource acquisition and poor access to natural

resources, (3) crop damage by flash flood, (4) declining productivity of crops, and (5) poor market linkage and value addition.

To cope with the climate change, the cropping

pattern in the Haor basin has been changed. Currently around 20 species of crops are being cultivated in the Haor, but the area was strictly a mono-cropper only a decade ago. Major crops in the Haor are listed below.

1. Rice varieties (BRRI dhan 29, BRRI dhan 28, BR19, BR14, Gochi 24, Rata and Jagli)
2. Pulse crop (mugh bean, lentil)
3. Oil seed (mustard)
4. Vegetables (radish, spinach, French bean, garden pea, sweet guard, red amaranth, stem amaranth, bitter gourd, potato, ash gourd, aroid),
5. Spices (onion, garlic).

Policy Potential

Bangladesh has number of laws that helps the conservation process of wetlands. Laws are on the rights of ecosystem and on people's participation and right on conservation action. The following are laws related to Haor resource conservation and protection on climate change concern.

- Acts Haor Development Board Ordinance 1997,
- Bangladesh Environmental Conservation Act 1995,
- East Bengal Protection and Conservation of Fish Act 1950,
- Bangladesh Wildlife (Preservation) (Amendment) Act 1974,
- East Bengal State Acquisition and Tenancy Act 1950, Land Reform Board Act 1989,
- National Rural Development Policy 2001

Bangladesh is the signatory to various treaties such as Ramsar Convention, Ganges Water Treaty 1996, CITES, and CMS. The Tanguar Haor is a Ramsar site. Hakaluki is an Ecologically Critical Area.

The Haor Master Plan (2012) aims to achieve sustainable development of the Haor areas by integrated planning and implementation through multi-organizational involvement and

community participation. In accordance with this direction of the Master Plan, the Project aims to achieve the development of the Haor areas through integrated approach. The Master Plan has proposed 153 projects for implementation under 18 thematic areas (including capacity building of the Haor and Wetland Development Board) at different time scales on a priority basis over a period of 20 years starting from 2012. Though there is no specific climate action on the Haor Area Master Plan but the Bangladesh Climate Change Strategy and Action Plan – 2009 is supportive of the Haor for climate action. BCCSAP-2009 is national strategy document delineated action plans to address climate induced threats at national scale. It has six pillars viz. i) food security, social protection and health, ii) comprehensive disaster management, iii) infrastructure, iv) research and knowledge management, v) mitigation and low carbon development, and vi) capacity building and institutional development. The Master Plan mentions three major climate related hazards viz. flood, cyclone and drought. However, flash flood and wave erosion of village mounds which affect agriculture and livelihoods in 7 districts has not been given priority but only flashflood has been lightly mentioned for the Haor area. The Plan mentions as - *“Flash flood can also be a problem in the more hilly north-eastern and south-eastern regions of the country”* (BCCSAP, 2009:9). One can interpret this statement as flash flood is still not a big problem in the country. It is mentioned that flash flood in the Haor happens only in plains, not in hill areas. But our finding shows that in the southeast region flash flood occurs in both hills and plains. This fact should have been clearly mentioned in the Plan. Moreover, the extent of flash flood and its damage and potential also vary significantly between the Haor and the south-eastern areas. These issues should be mentioned to design and plan preferential measures to address these problems through policy guidance/directives.

Response Capacity of Community

For the protection of lakes of the Haor basin the community needs to be responsive. A responsive community understands well the values of wetland resources, cultural norms and conservation

ecology. There is a scope of technology use and market linkages for the betterment of livelihoods. A responsive community can bring their voices in the process of decision making and their rights and entitlements are ensured in the process. The study found that for the Haor community to be more responsive to the climate action we need to build their capacity and raise their awareness. Basic adaptation framework should focus around the existing government structures (institutions) through the provision of necessary technical assistance and technology transfer in order to build sufficient capacity of the community to deal with disaster risk reduction, and climate change and adaptation matters, and to reflect the later in all development activities.

Way forward

Changing patterns of temperature in the Tanguar Haor (1.45°C) is significantly higher compared to the IPCC assessment over the world in last 100 years (1910- 1940: 0.35°C, 1970-2007: 0.55°C) (IPCC, 2007:252, Rahman *et.al.* (2015)). The change creates considerable negative impacts on crop production as well as livelihoods of local people. Loss of Boro rice crop from flash floods has become a regular phenomenon in the Haor areas over the recent years. Unprecedented flash floods in the Haor areas accounted for the loss of about 150,000 metric tonnes of rice at the beginning of 2010 (MoEF and IUCN). Adaptation to climate change at community level is considered as spontaneous or planned actions, modification, changes in behaviors, attitudes and practices in the way people struggle to maintain or improve their well-being and security owing to global warming and climate change, through formal and informal institutions. This includes a range of approaches currently practiced in the

development and climate discourse, including community-based adaptation, community-led adaptation, community-based disaster preparedness, disaster risk reduction, village and community development and sustainable livelihoods for communities/households/families. Implementation of climate action in a participatory way is essential for the Haor basin. To encourage community to manage their own natural resource and to cope with climate change, the community needs to do planning and designing whereas government and development actors may facilitate the process.

References

- MoEF and IUCN, not dated. Climate Change and Agriculture in Bangladesh Information Brief, Ministry of Environment and Forests, Govt of Bangladesh
- Rahman, M. M., Sajib, K. I. and Alam, I. A (2015) A Study on Climate Change Impact on The Livelihoods of The People in Tanguar Haor, Bangladesh. **Conference Paper** · XV IWRA World Water Congress, 25-29 May 2015, At Edinburgh, Scotland., Volume: Electronic proceedings of World Water Congress
- IPCC, (2007) "Summary for Policymakers, in Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B., Tignor, M. and Miller, H.L. (eds.), Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

Threat of Climate Change to Nature Conservation in Haor Basin of Bangladesh

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Abstract

Adverse impact of climate change has started posing a serious threat to the cultural beliefs and norms in the Haor basin of Bangladesh. The adverse climate situation has been keeping people away from practicing rituals. Because of serious changes in weather the usual characteristics of months in a calendar are being changed which makes cultural practices '*not fitting with the day*'. Many norms in the Haor basin is based on or associated with the local biodiversity. It was found that because of the connotation with God at least 11 wetland wildlife species are protected by the believers, Hindus and the aboriginal. The number of wildlife fauna recorded from sacred groves of the Hakaluki Haor was 77. Haor is bowl shaped shallow depression. It is a mosaic of wetland habitats found in northeast of Bangladesh and some parts of India. The people of Haor obtain their livelihoods from wetland and floodplain resources such as fish, swamp forest, reeds, aquatic fruits and wildlife. The climate change interferes with the production and breeding of the biodiversity. The rainfall pattern of the basin has changed, and first flash flood is around two weeks ahead as compared to last decade. Almost all festivals and worships

are associated with rice. Climate change causes displacement and migration. There is a break in the traditional flow of knowledge between the generations. It was found that only 17% of young people know traditional proverbs as compared with their grandparents. In the Madir Haor, one of smallest Haors in the country houses around 15 species of fauna conserved because of cultural norms. Unfortunately, population status of almost all culturally conserved wildlife is rare locally. Fisheries associated food festivals are held after crop harvesting; climate change amplifies the threats with interrupting breeding time. In the Haor basin there are many fairs associated with swamp and river vegetation. Erratic rainfalls and extreme temperatures cause the lack of water in the channels when required and the vegetative growth is disturbed. To cope with the adverse climate impact the community is practicing different adaptation options like new livelihoods, new practices of cultivation, new crops, etc. The new form of cropping is challenging the beliefs and norms to some extent. There are significant changes in housing in the Haor because of the short straw of the high yielding rice paddy. The changes in traditional navigations, housing, livelihoods and food because of development interventions result in deviation from the

traditional norms and practices which are being augmented by the climate change. The findings of climate change impact on the Haor culture is based on community consultations, informal interview and talk with elderly people in the Medir Haor, Hakaluki Haor and Tanguar Haor. The Tanguar Haor is a Ramsar site. The development projects by the Government and the development actors somehow have neglected the consideration of cultural values as a tool of natural resource conservation. There is a commercialization of some traditions that have high potential of promoting. The Master Plan of the Haor area somehow missed action for cultural and heritage protection but identified that tourism is thinkable with bird watching and historic palaces. Climate change is a reality and the Haor basin is noted as the second most vulnerable area to climate change in country. Integration of the capacity of cultural norms and practice in development intervention, conservation action and climate action only can make development sustainable.

Introduction

Haor is a bowl shaped shallow depression. It is a mosaic of lake habitats. The Haor basin in Bangladesh is bounded by the hill ranges of India from Meghalaya to Manipur and is extended from the foot of the Garo Hills to upper Surma Valley. The people of Haor obtain their livelihoods from wetland and floodplain resources such as fish, swamp forest, reeds, aquatic fruits and wildlife. The Haor inhabitants are farmers and fisher. The religious and traditional norms of the Haor community are associated with the natural resources of the Haor basin. Climate change is a new phenomenon and is, in fact, the nature and livelihoods of the Haor basin. Due to climate change, there is increasing frequency and intensity of disasters. Normally first flash flood comes in Haor between middle of April to end of April. But in recent years first flash flood is coming much earlier. The late first rain is interfering with fish breeding. Cold spell causes no grain in rice. To cope with the impact of climate change the community is practicing short duration crops and varieties. The Haor was mono-cropper but currently at least 14 species of crops are being cultivated by the community. Fish

sanctuaries of different forms are being practiced by the community. Bangladesh Wetland and Haor Development Board has drafted the Master Plan for Haor Area -2012 that will be executed for the next 20 years; Bangladesh Climate Change Strategy and Action Plan (BCCSAP) considers the Haor as a special zone because of the climate vulnerability.

Methodology

The study was conducted in the Medir Haor, Hakaluki Haor and Tanguar Haor. The Medir Haor is one of small Haors in Bangladesh located in Brahmanbaria District. Hakhaluki in Moulvi Bazar District is said to be the largest Haor of the country and the Tanguar Haor located at Tahirpur of Sunamgunj District is a Ramsar site. Following are the information collection methodologies:

- Field observation
- Community consultation: Four consultations were conducted with the community
- Key Informant Interview: 16 knowledgeable individuals were interviewed.

Results

Religion in the Lakes of Haor

There are both Muslim and Hindu communities living in the Haor basin. There are a few aboriginal communities but majority of them are the Hindus. The Hindus and other indigenous community worship wetland and wetland creatures. Around 35% people depending on the lakes of Haor was found Hindu. The Hindu communities have made many lakes sacred due to the association of God and Goddess. Those associated with God and Goddess was found protected. Worship of those God and Goddess with their mounts (animal and plants) is also common. Worship of net as Goddess Ganga is very common in the Haor areas. The Goddess of snake is also named as Bishohari. The goddess Bishohari is also worshiped in form of mud pot having snakes around.

Sacred Plants and Animals and Associated Goddess:

Animal / Plant	God/Goddess/ Folk faith
Dolphin/ Crocodile	Ganga
Cobra	Monasha
Water Lily	Mariguli
Lotus	Durga/ Buddha
Water herb	Garoi
Bhat flower	Protect House
Water Hyacinth	Krishna

Norms and beliefs

There are many norms and beliefs in the Haor lakes by which some plant and animals are found conserved and protected. Local people because of the norms are not harvesting or disturbing those animals and plants. If there is any accidental catch of those sacred animals, they try to release them within a short time. The norms and beliefs recorded from the studied Haors are as follows:

- Gangetic Dolphin is the carrier of the river goddess Ganga, so it's a holy animal and should stay undisturbed
- Killing of birds with chick is sin
- Killing the bird brain-fever is sin as this bird cries for sick wife
- Eating fry of snake-head fishes is not right
- Spotted snake-head is holy fish
- Turtle is forbidden in Muslim religion
- The water spiders are also gods because spider protected the Prophet

- The skunk is the aunty of snake. If disturbed the skunk will inform the snake and the snake will take revenge
- Fish is the sign of good luck
- No fishing on full moon and dark days

Sacred Wetlands and Grove

Sacred wetlands and associated habitats are free from harvesting of natural resources. The Anutpurer Mora in the Medir Haor becomes isolated from the village. During monsoon the village mound becomes an island. Major plants and wildlife found in this place is 70 plus. Dulkandi is a holy tree located in the middle of this wetland. During monsoon, it is the only habitat of snake, lizards and bats.

Interference of Climate Change with Seasons

It was found that the character of the seasons in the Haor basin has been changing significantly. The season is shifting of a month in the calendar. Though the months of first quarter in the native calendar is like one month earlier but in other quarters there is no change (Figure 1).

	Mar	April	May	June	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Month	Baishakh	Jyasta	Ashar	Shrabon	Vadro	Arshin	Kartik	Agrahan	Push	Magh	Falgun	Chaitra	
Behave as	Chaitra	Baishakh	Jyesta	Shrabon	Ashar	Sharbon	Arshin	Poush	Arshin	Poush	Chaitra	Falgun	

Figure 1: Changes in Months

Climate Change Impacts on Folk Festival

It was found that there is a huge deviation in the practice of folk festivals. Though there is a rapid rising of religious practices globally, but the folk festivals are gradually getting less importance. Climate is one of the major factors of creating such change. Out of 17 major folk festivals of the Haor basin it was reported that 12 has been

interfered by climate change. Climate change impact on folk festivals is as follows:

1. Lengribrotois in Baishakh. It is to celebrate the harvest of rice and the worship is done by offering rice cake. To cope with climate change, the community is cultivating new varieties of rice. The festivity is no more linked with just harvested rice only.

2. Hattaibroto/ Friendship day (in Jestya) is celebrated with the flours of corn and cereals. The friends, mostly the married women, offer dishes of different cereal flours to their friends. Due to late monsoon, the local farmers are not cultivating many varieties and species of cereals. The adaptation to climate change is increasing monoculture of paddy.
3. In the Halbangha there is no digging/ ploughing from the 7th to 10th Ashar. But farmers are not following this because of the erratic rainfalls. In a rain-fed farming it is not possible to follow this practice.
4. In Sidhyswaribroto in the month of Vadra 7 type of cakes are required: Frequent flooding is not favorable to cultivate different types of crops.
5. In the last day of Arshin there is Garoi. Eight vegetables have to be cooked to worship the forefathers. Prolong flooding has reduced the growth of wild vegetables.
6. The last day of Kartic is celebrated by burning a straw made devil structure called Bhulapura. The burning is to keep mosquitoes and vector-borne diseases away from villages for the rest months of the year. There is no more geographical or time barrier for insect pest due to global warming.
7. In the last days of Poush there is Poush Parban. In Poush Parban a temporary hut made of straw is put on fire: To cope with flash flood community is cultivating short duration early variety of rice that have short straw
8. Bagherbroto/ Tiger worship is in Magh. People sing song and visit door to door to collect rice, vegetables and money to celebrate the tiger festival. It was fun to see the tiger dance. Nowadays, there are no cold days and thus no festivity.
9. Maghbur/ Bathing in winter (in Magh): A few winter days, so no festivity
10. In the Kunai broto a jujube branch with fruits is needed for the worship. It was found that the jujube flowering is early now.
11. Ghatabandis in Falgun. The periphery of house is decorated by white wild flowers of *Bhat* plan to keep the evil away from the house. As the flowering is late, the people are using other flowers, but preference is given to white-coloured flowers.
12. In the last day of Chaitra it is Harbishu. People eat sour vegetable as a tradition. Belief is that there will be no epidemic or disease next year. Many vegetable dishes are cooked. As the last quarter of the year turns dry and due to localized drought, there is less growth of wild leafy vegetables.

Impact of Climate Change on folksongs

In the Hoar basin, there were songs that detail the life of individuals for the whole year. The interaction with the hazards and challenges of every month are described in the song. The songs are mostly love and religious song. Due to changes in the character of the months the descriptions on those ‘Baromashi’ songs are no more accurate. As, for example, in the *Dukhinir Baromaisya*, a Haor woman is describing the year-long struggle and sorrow as follows:

- This Ashar, it’s raining cats and dogs! also lightening;
- There is thunderstorm, I am scared;
- I have none to care me, I am alone, you are in abroad

But the description of the ‘song of twelve months’ is not accurately describing the Ashar of nowadays.

Discussion

Analysis and understanding of the social, behavioural and ethical dimensions of climate change are still at an early stage. There is a complex relationship between social, behavioral and ethical aspects of climate change (Christie, et. al. 2010). Acceding to the local community in the Medir Haor the practicing folk culture brings people of different race, religion, economy together. Loss of cultural practices makes

opportunity of mass gathering and cooperation among people. Jones (2010) based on his field finding from western part of Nepal found that a failure to recognize social barriers can have dramatic consequences for an individual's capacity to cope with climate hazards, variability and change. So, in a development planning where climate change is a fact, understanding the local norms and culture is a must. Devkota (2013) has identified that climate change has interfered with the culture and social-economic status of the Himalayan people including livelihoods and food being changing, the glacial melting are the main cause here for the change. Erratic rainfall and the resulted floods were identified by the community as the main force of troubling the rituals in the basin. The evidence of severe imbalance on the cultural and religious calendar was also found in India. Indian culture and faith traditions have very strong connections to weather patterns embodied in language, stories and festivals. One of the key ways by which people notice and measure the shift in climate is in relation to these cultural benchmarks, and the dates of festivals. These are also a key way to initiate and maintain a public conversation, for example, when there is no wind for a kite festival, the harvest is too

early for a harvest festival, or a fruit, vegetable, flower or bird associated with a particular event is not available. (Marshall et. al. 2017). Proper documentation and facilitation on celebration and practice are essential and were recommended by the Haor community.

Reference:

- Christie, I., Jackson, T., and Rawles, K. (2010). International Dimensions of Climate Change Report: 1.3: Ethical, Social and Behavioral Impacts of Climate Change, The UK Government's Foresight Project on the International Dimensions of Climate Change
- Devkota, F. (2013). Climate Change and its socio-cultural impact in the Himalayan region of Nepal – A Visual Documentation. *Anthrovision* [Online], 1.2 | 2013
- Jones, L. (2010). Overcoming social barriers to adaption. ODI
- Marshall, G., Yashwant, S., Shaw, C. and Clarke, J. (2017). Communicating climate change in India: a Global Narratives project. Oxford: Climate Outreach.

Assessment of Physico-chemical Parameters of Uttara Lake of Bangladesh

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Abstract

Dhaka is located in the geographic center of the country. Water is a primary need for human survival and industrial development. Lake plays an important role to maintain ecosystem and in creating recreation particularly in urban area. The Uttara Lake is the part of long demand of the urban dwellers for their physical as well as mental nourishment. The study was conducted in the Uttara Lake to investigate the physico-chemical parameters of water. The Lake is almost 1.8 km long. The road has divided the lake into four sections. Water samples were collected from three sections of the lake. A total of 9 samples were collected where 3 samples were from each section. Different types of portable instrument were used for water sample analysis. The study found that, maximum values for pH, Temperature, Total Dissolved Solid (TDS), Electric Conductivity (EC), Dissolved Oxygen (DO), Turbidity, Salinity and Visibility are respectively 9.7, 24.40c, 304 ppm, 620 $\mu\text{S}/\text{cm}$, 2.1 mg/l, 63.9 NTU, 1.8 ppt and 21 inch whereas minimum values are 9.1, 24.20c, 196 ppm, 375 $\mu\text{S}/\text{cm}$, 1.1 mg/l, 16.11 NTU, 0.3 ppt and 14 inches respectively. The direct observation suggests that the watercolour of the lake is very dark and black. It is severely polluted due to frequently dumping of waste, random

dumping of household wastewater and visiting of people. Awareness program is necessary to stop unauthorized activities that seriously lead to pollution of the lakes and its surrounding environment.

Key Words: Physiochemical Parameters, Winter Season, Water Quality, Lake Environment

Introduction

Dhaka city is expanding day by day with the increasing rate of population; nowadays it has become a regular event that lake area is used up by land grabbers. As a result, all the lakes in Dhaka city are becoming narrow day by day. The Uttara Lake, one of the largest water bodies of the capital, is dying now due to serious contamination. Lakes are no longer attractive to the eye and reduced almost to a drain. Conservation of water bodies is a major issue all over the world. Rapid urbanization together with encroachment, leading to the loss of catchments of surface water bodies and problems of siltation and pollution, which includes domestic, industrial and agricultural waste including eutrophication are the major problems of the world to protect and control water resources (Jagdish Singh, 2012).

Though most of the lakes of Dhaka city are now more or less occupied due to formal and informal

settlements, the lakes are still an integral part of the eco-system. A lake (from Latin *lacus*) is a terrain feature, a body of liquid on the surface of the world that is localized to the bottom of basin and moves slowly if it moves at all. They act as water retention basins during the Monsoon, and besides being the sources of biodiversity of the area, they are an important part of the scenic beauty.

Study Area

The Uttara Lake situated in the northern part of Dhaka city. The Lake is located at the coordinates of 23°51'46.4"N latitude and 90°23'34.6"E longitude to 23°52'45.7"N latitude and 90°23'39.4"E longitude (Figure 1). This lake is 1.8 km long and has been crossed by the road for four times. Uttara residential area are situated beside the lake.



Figure 1: Study Area Showing Sampling Site

Methodology

Water samples were collected from three points of Uttara Lake. Total 9 samples were collected from the Lake, 3 samples from each. Sampling was collected in winter seasons in December 2017. For further analysis samples were collected in 500 ml bottles. Standard procedures were used to analyze the physico-chemical parameters of the water samples. GPS Meter (Garmin etrex 10) for geographic coordinates, visual inspection using Secchi Disk for visibility, thermometer (Eurolab ST9269B) (Graduated 0°C to 100 °C) for temperature, DO Meter for Dissolved Oxygen,

single electrode P^H meter (Jenway pH meter, model 3305) for pH, EC meter (range 0-1999 µS/cm) for electrical conductivity and TDS (model TDS3/TEMP) meter (range 0-9990 ppm) for Total Dissolved Solids and salinity meter for salinity were used in the field for measuring some physico-chemical parameters. For measuring the physico-chemical parameters standard procedure was followed according to the instrument manuals. For the statistical analysis and tabulation Microsoft Excel 2007 was used. All the graphs and figures are also illustrated by using this particular software.

Result and Discussion

The quality of water is a vital concern for mankind since it is directly linked with human welfare. The major sources of water pollution are domestic wastes from urban and rural areas, and industrial wastes, which are discharged into natural water bodies. Water samples were collected for some

important parameters like – Temperature, pH, Total Dissolve Solids (TDS), Salinity, Electrical Conductivity, Dissolve Oxygen (DO) and Visibility. Figure 2 shows the temperatures of different sampling locations. The study found that maximum temperature was 25.4°C whereas the minimum is 24.2° C. Bangladesh standard temperature is (20-30) °C.

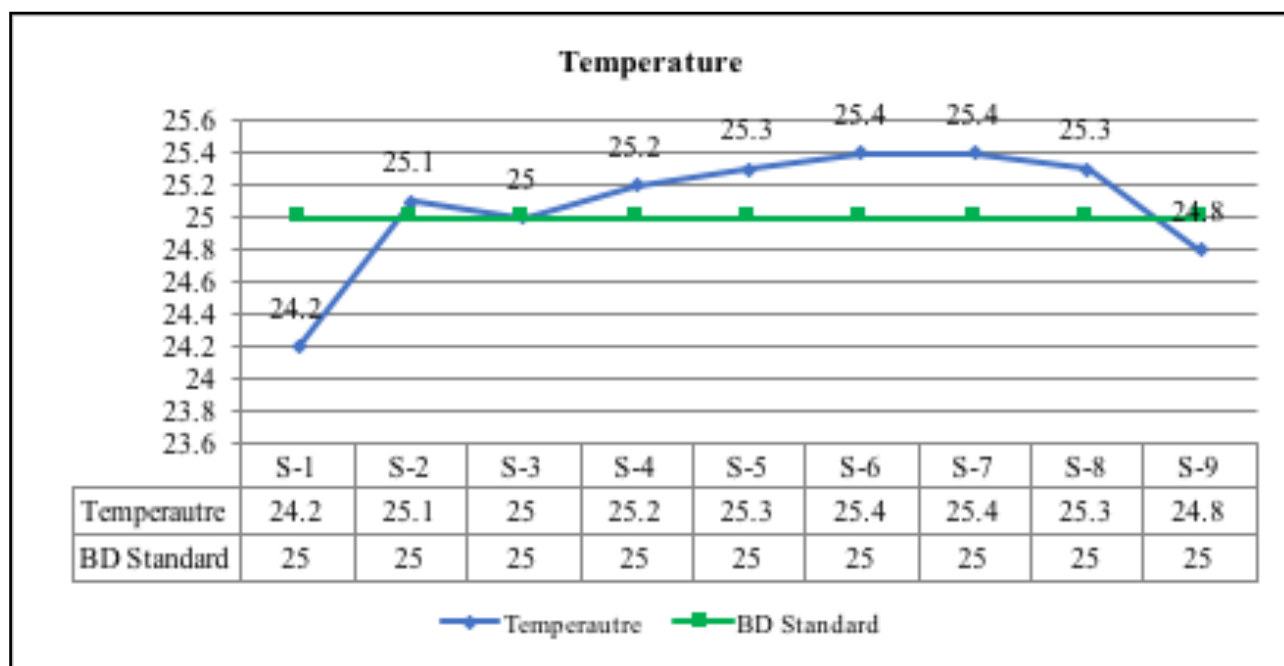


Figure 2: Temperature of water samples from different locations at Uttara Lake

Figure 3 shows the maximum pH level found in the sample 1 & 2, whereas the minimum pH level is 9.1 for the samples 6 & 7. According to

Environmental Conservation Rules 1997 (ECR) the standard for pH is 6.5-8.5. All of the sampling points of pH exceed the standard limit.

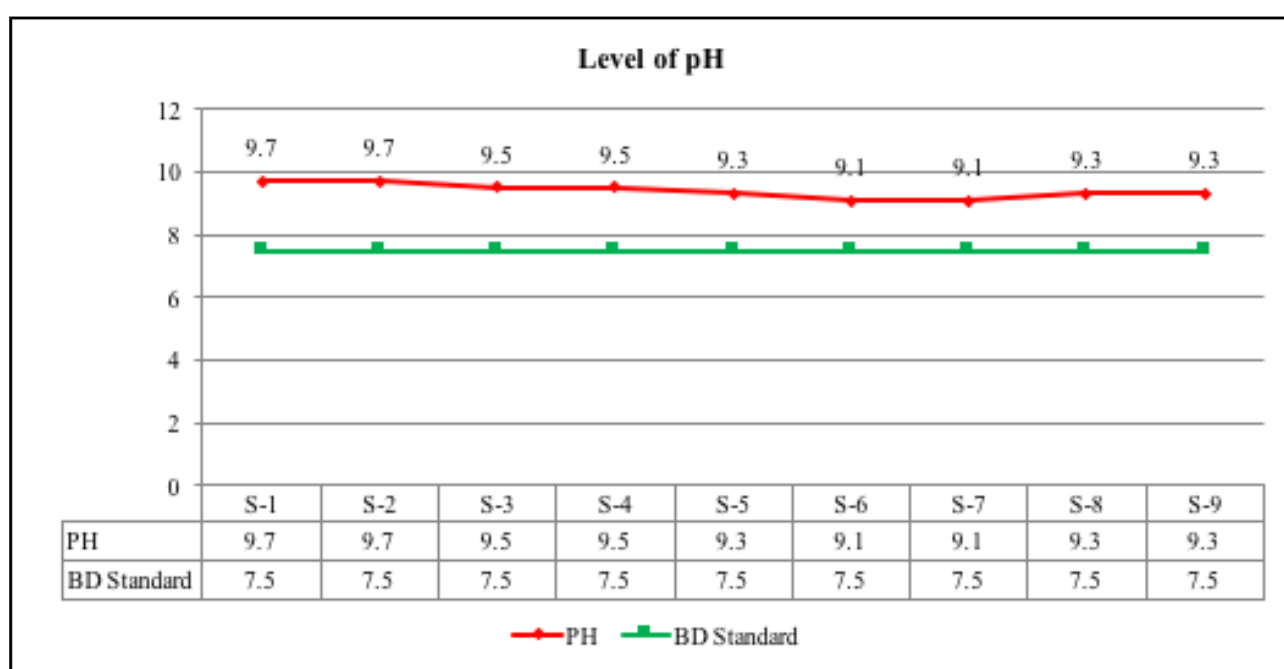


Figure 3: pH level at different sampling locations of Uttara Lake

Figure 4 shows the maximum TDS found in sample 9 whereas the minimum is from sample 2. According to ECR 1997, for surface water the

standard TDS value is 1000 mg/l. So, the TDS value of all sampling area is within limit.

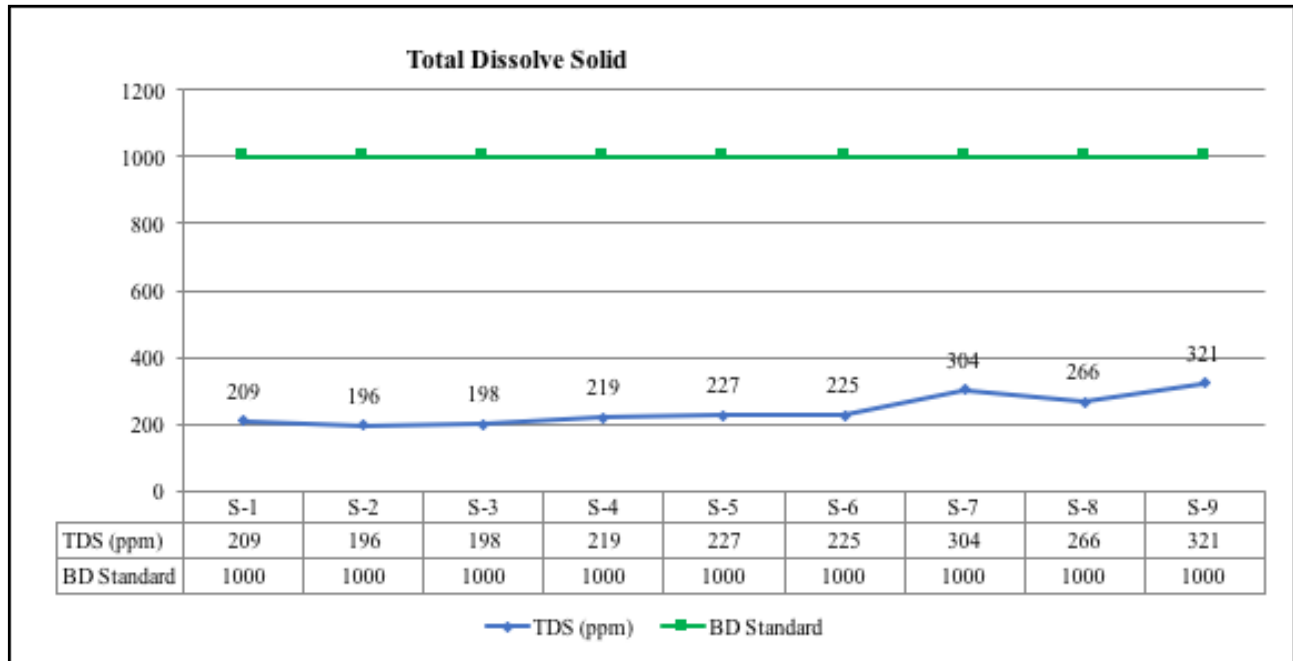


Figure 4: TDS level at different sampling locations of Uttara Lake

Figure 5 shows the maximum turbidity level is 63.9 NTU in Sample 9 whereas the minimum level found is 16.11 NTU in sample 2. According

to ECR 1997, the standard value is 10 NTU. So, all of samples exceed the limit of standard.

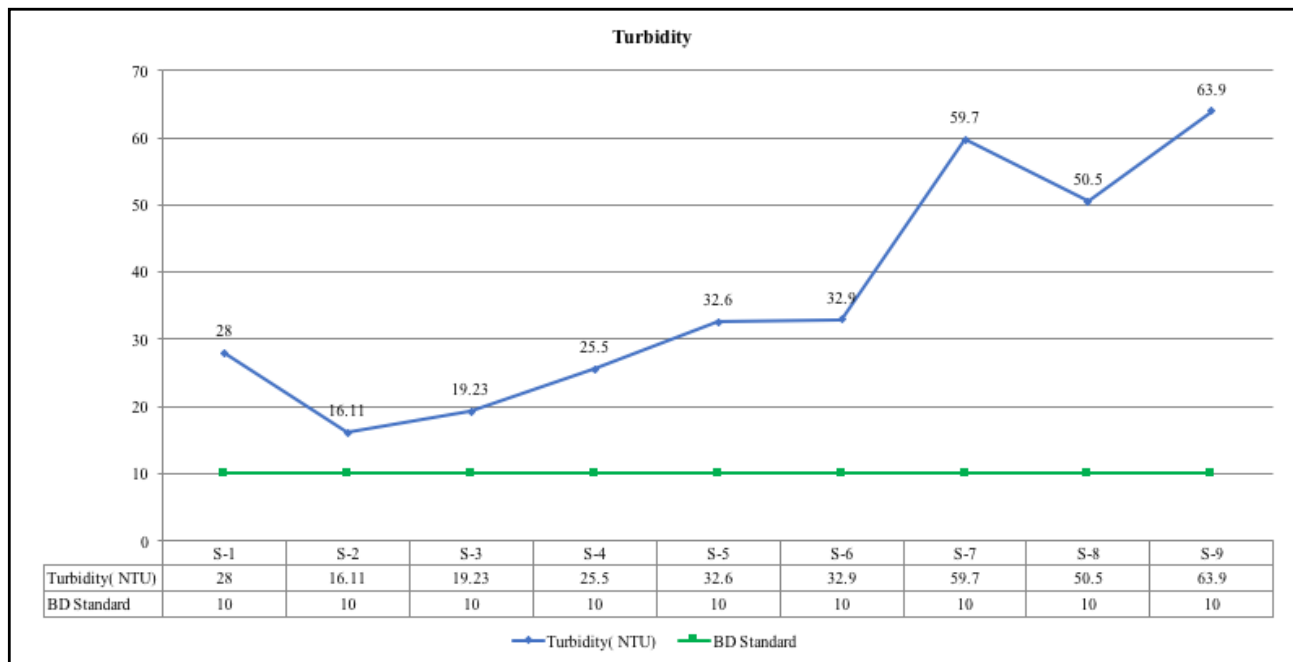


Figure 5: Turbidity level at different sampling locations of Uttara Lake

Figure 6 shows that the maximum DO value is 2.1 mg/l, whereas the minimum DO is 1.1 mg/l. The result also shows that all of the sampling points

are under the standard level of DO. According to ECR 1997, the standard value for DO is above 6 mg/l for surface water body.

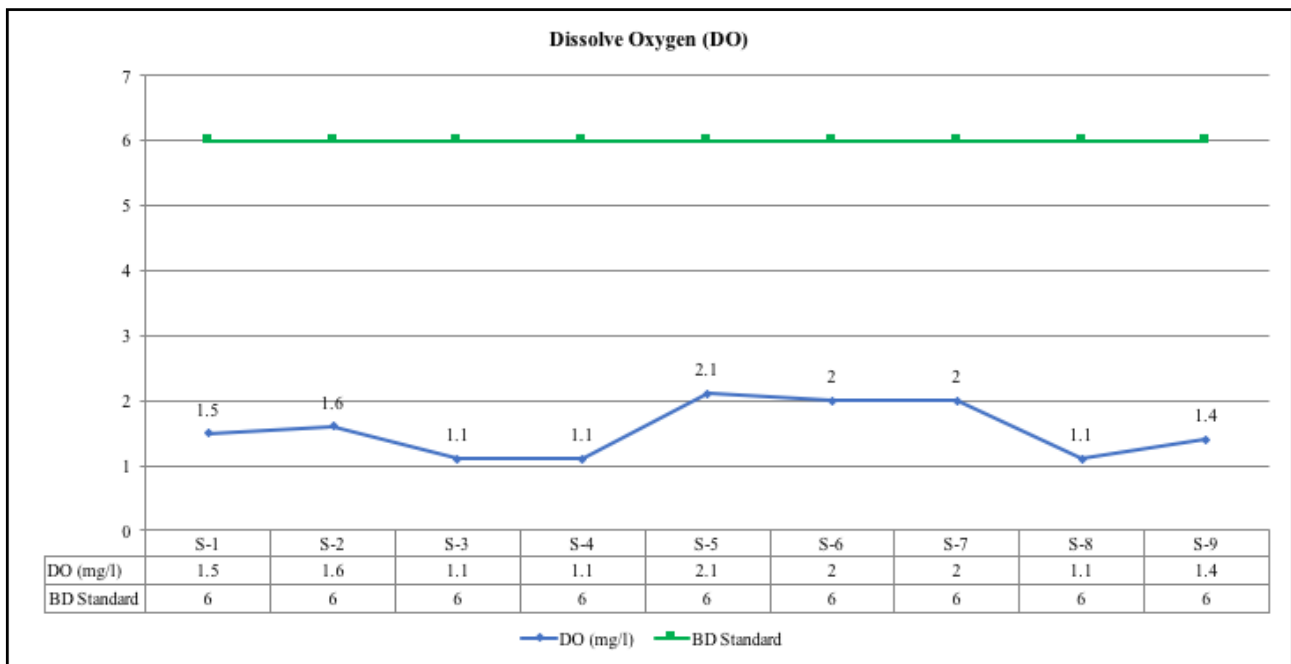


Figure 6: DO level at different sampling locations of Uttara Lake

On the other hand, we found maximum visibility is 14 for sampling 9. But all of the visibilities are as 21 inches for sample 3, whereas the minimum not within good level (Figure 7).

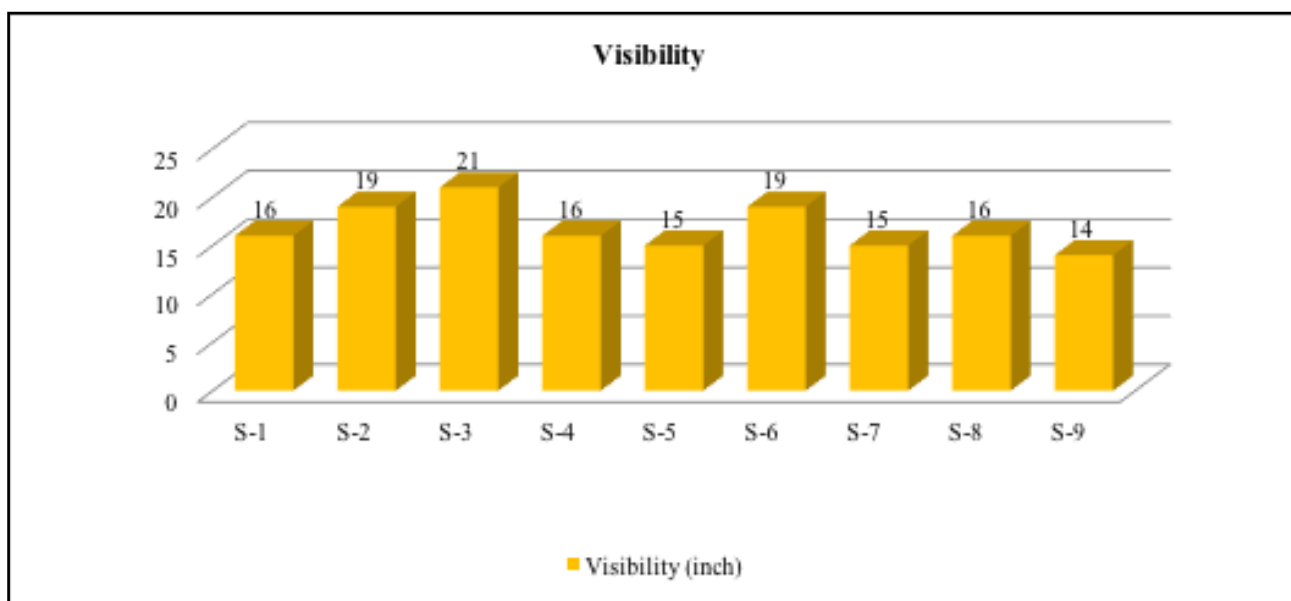


Figure 7: Visibility at different sampling locations of Uttara Lake

Figure 8 shows the level of salinity. The level of salinity is within the standard level. But we should be sure that it does not increase. Figure 9 shows electrical conductivity range in the lake water.

Sampling points 1, 7, 8, 9 and 10 cross the limit of standard for electrical conductivity. Increasing the TDS value is equivalent to EC value.

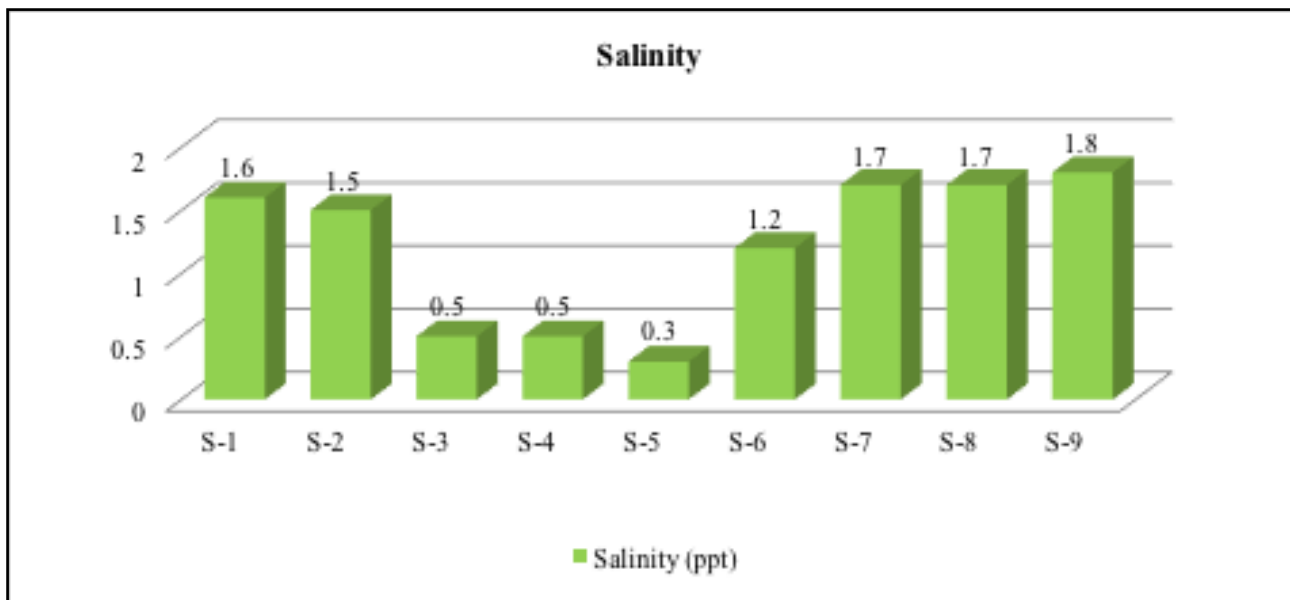


Figure 8: Salinity Level

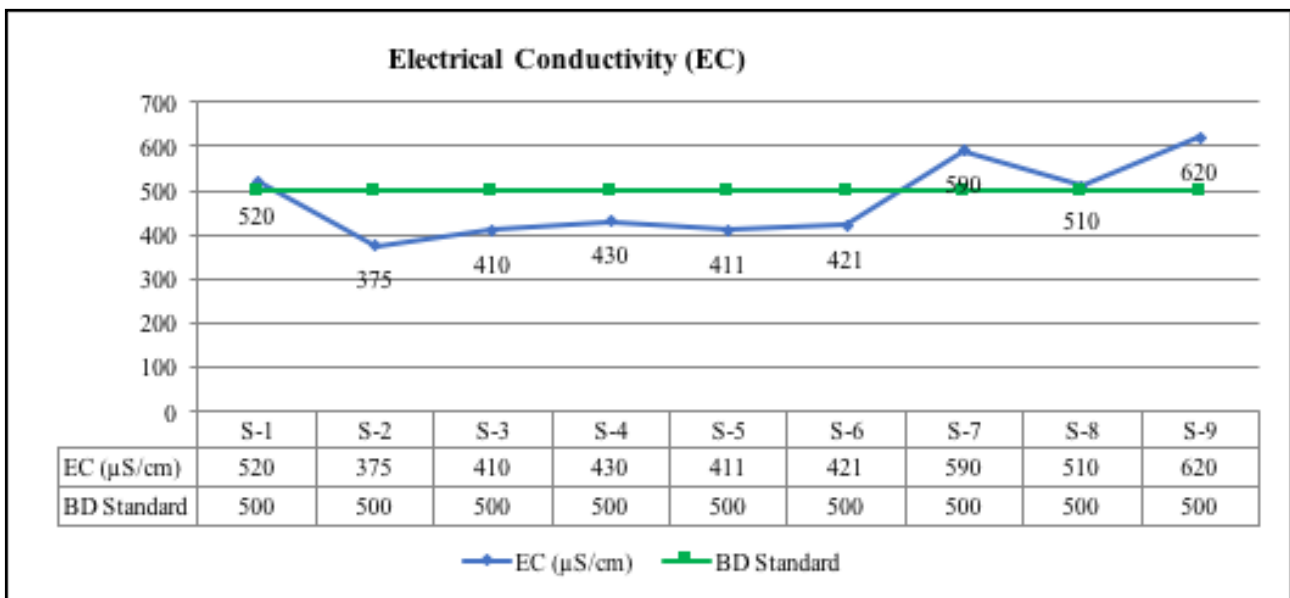


Figure 9: Electrical Conductivity

The eye observation says that the water color of the Uttara lake is very dark and black. Due to discharge of household and other waste waters from different sources into the lake, the water has been very dark black and polluted. For all of these reasons fish cultivation and growth of some microorganisms are hampering.

Conclusion and Recommendation

Uttara Lakes is a precious asset of Dhaka city with unique regional characteristics. Apart from its scenic beauty, it has great economic and environmental values. During extremely dry seasons, the lakes retain considerable amount of water. These water bodies account for fisheries

and provide a habitat for a wide variety of aquatic vegetation and birds. But nowadays this lake is highly polluted lake of Dhaka city. The sewage from residential area is directly released to the lake which is the main reason of pollution of lake. We can see in our result that maximum parameter is not within the standard level. And mostly it is high in sampling points at 7, 8 and 9. The sewage water is released into the north section of the lake. That is why the pollution is much high in this section. Then it is spreading to another section which creates a hazard to aquatic animals. So, more intensive sampling and analysis including sampling of water from different depths and more spatial locations would better describe the lake water quality. Sewage treatment plant

would be the option for reducing the pollution of the Uttara Lake. And finally, awareness and the enacting law would help reduce the pollution of our beautiful lake.

References

- Ahmed, S. U. (1986) *Dacca: A Study in Urban History and Development*. London: Curzon Press Ltd.
- Akonda, A. W. 1989. Bangladesh. In: *A directory of Asian Wetlands*, Scott DA (Ed.), pp. 541-581. IUCN, Switzerland and Cambridge.
- Barua, S. (2008) *Towards Interactive Urban Flood Management: A Case of Dhaka, Bangladesh*. Master Course in Urban Management and Development, Rotterdam: Faculty of Social Sciences, Erasmus Centre for Sustainability and Management - Erasmus University Rotterdam.
- De Groeve, P.; Naesens, I.; Peeters, S.; Van Reeth, L. (2010) (Re-) Integrating the Inner City Water Bodies in Dhaka, Bangladesh, (unpublished master thesis). Leuven: KUL.
- ECR 1997, *The Environmental Conservation Rule*.
- Hossain, M. Z., Kabir, G. M. A. and Quraishi, S. B. 2010. Contamination of Dhanmondi and Gulshanlake waters with some metals and inorganic pollutants. *Bang. J. Academy of Science*, 34(1): 89-93.
- Islam, A. K. M. N. and Saha, J. K. 1975. Limnological studies of Ramnalake in Dhaka. *Dhaka Univ. Stud.*, B. 23: 39 - 46.
- Islam, I. (2009) *Wetlands of Dhaka Metro Area. A Study on Social, Economic and Institutional Perspectives*. Dhaka: AH Development Publishing House.
- Islam, R. (2009): *Investing of Surface Water Quality of the Hydrological Environmental of Dhanmondi Lake*; Unpublished Project Paper, Department of Environmental Science, Stamford University Bangladesh.
- Jagdish Singh, (2012) "Water Conservation Methods to Overcome Scarcity, Pollution and Contamination of Water Resources, India", *International Conference on Chemical, Ecology and Environmental Sciences (ICEES'2012)*, Bangkok, March 17-18, 201.
- N. R. B. Razzak, S. Y. Muntasir and S. Chowdhury, (2012) "Pollution scenario of Dhaka city Lakes: A case study of Dhanmondi and Ramna lakes". *Global Engineers & Technologists Review*, Vol.2 No.7 July 2012.
- Nilufar, F. (2000) *Urban life and use of Public Space. Study of responsive public open spaces for supporting urban life in Dhaka City*, (unpublished research report). Dhaka: The Asiatic Society of Bangladesh.
- Novak, J. J. (1993) *Bangladesh: Reflections on the Water*. Bloomington: Indiana University Press. RAJUK (1995a) *Dhaka Metropolitan Development Plan*, Volume 1. Dhaka.
- Parvin, M. M. (2007): *Quality of Life in Dhaka City: A GIS and Environmental Approach*; Unpublished Thesis, Department of Geography and Environment, University of Dhaka.
- Sultana, M. N. (2016): *Study of Physicochemical Parameters and Zooplanktons of Shahidullah hall Pond*; Unpublished Project Paper, Department of Environmental Science, Stamford University Bangladesh.
- Taylor, James (1978), *Topography of Dacca (1840)*, all references from the recent Bengali translation: Asaduzzaman, M. Company Amaler. Dacca. Dhaka: Bangla Academy.
- Trisha M. M. (2017), *Assessment of Physicochemical Parameters of Dhanmondi and Ramna Lakes*. Unpublished Project Paper, Department of Environmental Science, Stamford University Bangladesh.

Integrated Lake Basin Management of Chilika Lake: A Journey from Montreux Record to Ramsar Wetland Conservation Award

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The Chilika lake is the largest brackish water lake in India and a Ramsar site. It is a unique assemblage of marine, brackish and freshwater ecosystems with estuarine characters and a hotspot of biodiversity and a wintering ground for more than one million migratory birds. The lake basin and coastal process are integral factors determining the ecological integrity of this coastal wetland. The freshwater inflows drive the temporal and spatial salinity dynamics of the lake, which contributes to the mosaic of aquatic habitats for different plant and animal species, and the different life cycle requirements of these species. It is primarily this dynamic salinity regime that enables the lake to support high biodiversity and a productive fishery. The highly productive ecosystem of Chilika lake sustains the livelihood of 0.2 million fishers and 0.8 million watershed community. The lake encountered a combination of increased siltation due to changes in the land use pattern and degradation of the lake basin, as well as the partial closure of the inlet connecting the sea. The decrease in salinity caused proliferation of invasive species, increased turbidity, shrinkage of the water-spread area, loss of biodiversity, and drastic depletion of fishery resources. Due to changes in its ecological characters, it was included in the Montreux Record, maintained by

Ramsar Bureau, in 1993. In response to the action by the Ramsar Convention, Chilika Development Authority (CDA) was created for the restoration of the lake by the Government of Odisha. CDA initiated an integrated lake basin management approach promoted by the ILEC Foundation to address the complex ecological and socio-economic issues of the Chilika lake for restoration and sustainable management of the lake and its basin. The six-governance pillar, ILBM approach i.e. (i) institution, (ii) information (iii) technology (iv) participation (v) policy & (vi) finance was adopted by the CDA in the formulation of a strategy for restoration and management of the lake.

As the first step of the ILBM, platform constitution of an enabling “Institution” i.e. Chilika Development Authority (CDA) with the Chief Minister of the Province as Chairperson was accomplished. This provided the desired strong commitment in the form of “Policy” support from Government of Odisha for the restoration and sustainable management of the lake. To develop the strategy for restoration of the lake, the CDA commissioned the services of premier institutes of the country to trace the root cause of degradation through targeted scientific studies and extensive

stakeholders' consultation. Based on the outcome of the study and the scientific information and wide consultation, the appropriate strategy was developed to restore the lake to its former healthy state. The lake basin spreads over 4000 square kilometers and was the logical starting point for planning and management actions. The environmental flow assessment provided necessary clues regarding the significance of the freshwater flow from the lake basin to maintain the ecological integrity of the lake. The large-scale silt flow from the lake basin (0.365 million cubic meters, assessed through the stream flow measurement) was identified as one of the biggest management problems. Further assessment revealed that land degradation in the lake basin not only leads to enhanced silt flow into the lake but also causes poverty, due to low productivity in the lake basin. The chief livelihood strategy adopted by the watershed community is rain-fed paddy cultivation once a year. The average annual rainfall received is 1400 millimetres, but because this average is not consistent, total or partial crop failure is a common phenomenon. In spite of the endowment of natural ecosystems, which could have constituted a livelihood provider for the agricultural communities with sustainable income generation and adequate employment opportunity, due to degradation of the basic life support system, the agricultural productivity was low. Poor crop productivity had been adversely affecting the livelihood of the watershed agricultural community, consequently triggering migration in search of employment. An innovative integrated participatory micro-watershed management concept was adopted with a "sustainable rural livelihood" approach for holistic management of natural resources. The drainage basin management program was conceived as a long-term participatory process. The objective of this concept was to facilitate the community through empowerment to take decisions and build capacity to work collectively. The participation of local communities and stakeholders in planning and implementing management of natural resources and in sharing the responsibilities of decision-making is a key feature of the ecosystem approach. The focus was on the restoration and conservation of a degraded life support system within the micro-watershed. An analysis of needs, value and perspectives of

local communities are fundamental to ecosystem management. To achieve this, an innovative grassroots approach was adopted by the CDA, by formulating a micro-plan, blended with indigenous knowledge and appropriate experts' input, for optimum utilisation of the natural resources in a sustainable manner and to increase productivity and provide equal opportunity for livelihood for the landless, marginal farmers and women.

One of the most successful initiatives was a series of rainwater harvesting structures, which they designed and installed. They succeeded in recharging aquifers and transforming local ecosystems as well as their surrounding economies. The advantage of the system is that along with capturing rainwater; it improved the moisture regime in the field, particularly downstream - this acts as insurance against crop failure, a frequent occurrence. The villagers say that after 2001 there have been a rise in agricultural productivity and two crops can now easily be grown annually. It is believed to be a result of both the water harvesting and regeneration of forests. Emigration also significantly decreased with the increase in agricultural production and creation of employment opportunities for the landless labourers. Notably, there have been increased earnings from land and non-land activities for the distressed, reduced debt, and improved livelihood and food security leading to further poverty alleviation reduced environmental degradation and reduction in the silt load into the lagoon. The outside migration in search of employment has decreased by 80%.

By the use of technology, i.e. rigorous numerical modelling of the coastal processes, it emerged that the tidal influx into the lake was adversely affected by the shoal formation along the lead channel and continuous shifting of the mouth due to littoral drift. This had been adversely affecting the natural recruitment of species through the mouth opening to the sea. Based on the outcome of the numerical modelling, opening of a new mouth was recommended to address this problem. Before going for such major intervention, CDA interacted with the scientists of Lake Saroma, Japan, where similar successful intervention was carried out. With the exchange of knowledge and expertise, a straight cut was made, bringing the

mouth closer to the lake by 16 kilometers. After this hydrological intervention, there has been a significant improvement of fishery resources due to auto-recruitment, increase of the tidal and salinity flux into the lake resulting in achieving desired salinity gradient, flushing out of sediment to the sea, the decrease of freshwater invasive species, and overall improvement of lake ecosystem and biodiversity. The hydrological restoration resulted in the spectacular recovery of fishery resources of the Lake, immensely benefitting, 0.2 million fisher folks who live in and around the lake. Before the restoration, the annual fish landing for the lake had declined to 2000 Mt. per annum, but after the restoration, there has been a seven-fold increase in the fish landing which has now touched 14,000 Mt. per annum. The valuation at the average weighted price due to the enhancement of the fishery resources alone after the restoration stands at 16.19 million US\$ per annum. It is a perfect example of how the restoration of a wetland with most appropriate strategy can not only restore the ecological integrity of the wetland but also can contribute significantly towards the improvement of livelihood of the local community due to increase in the productivity. In spite of the significant improvement of the fish catch it was observed that the economic condition of the fishers did not improve. This was because they were under severe debt trap and overexploitation by money lenders. To overcome this problem, a Federation of Primary Fishermen Co-operative Society was constituted, and institutional financing mechanism was arranged. This immensely benefited the fishers in getting out of the debt trap.

The strategy adopted by the CDA is a good example of the application of the ILBM Platform, to address complex issues in restoring the ecosystem. It is also a perfect example of how the restoration of a wetland with the ILBM approach can not only result in ecological integrity of the wetland but also can contribute significantly towards the improvement of livelihood of the local community. It is a good demonstration of successful translation of the ILBM platform into action. To achieve the sustainability an integrated management plan outlining the management strategy to identify the long-term management objectives is formulated based on the ILBM principles and the Ramsar guidelines.

To promote responsible fishery and wise use of the lake resources and to ensure participation of all stakeholders, extensive CEPA activities were carried out in collaboration with local NGOs and CBOs. Ramsar Center Japan provided significant support for successful implementation of the CEPA activities. Experience from successful management of wetland has shown that devolving decision-making power over the use and management of natural resources to local communities can yield tangible benefits in terms of livelihood and food security, new and more equitable power relationships (including for women) and better environmental stewardship and sustainability. So, for post-restoration sustainability steps were taken to secure rights of the local communities to wetland resources, as well as access to environmental information, markets, and decision-making to enhance their capacity to do the wise use of the wetland resources.

The lake ecosystem is restored, and its resilience was also put to the test post severe cyclonic storm Phailin in 2013. The Lake turned out to be an entirely freshwater putting severe pressure on the complex lake ecosystem. However, within six months the ecosystem recovered testifying its incredible resilience. Still, some management issues need to be addressed. There is an urgent need for legislation to regulate the lake resources and curb the illegal shrimp culture. The draft legislation is pending for quite some time with the Government which needs to be expedited as on the other hand there is a danger of overexploitation leading to resource depletion. This will adversely affect both the community as well as the rich biodiversity of the lake.

The restoration strategy adopted by CDA derives its uniqueness from the firm participation by local communities, linkage with various national and international institutions including ILEC Foundation and intensive monitoring and assessment of the system and its global relevance. The Chilika Lake was removed from the Montreux Record (first from Asia) in 2002, and the Chilika Development Authority received the prestigious Ramsar Wetland Conservation Award for the successful restoration of the wetland.

Conservation Measure: Moeyungyi Wetland Wildlife Sanctuary

Dr. Thiri Dae We Aung

Biodiversity and Nature Conservation Association.

Abstract

Moeyungyi Wetland Wildlife Sanctuary was the first Ramsar site in Myanmar. It has been identified as one of 19 sites qualifying for Global Conservation Significance based on different criteria. Baseline surveys of the status of biodiversity and socio-economic status were carried out in 2013. The results were disseminated to all stakeholders, including people settled in 17 villages around the wetland, with a view to make them aware of the threats facing the wetland and to involve them in developing solutions for the conservation of the wetland. All local stakeholders assessed the management of the Moeyungyi Wetland Wildlife Sanctuary by SWOT analysis. They demonstrated the range of benefits that the Moeyungyi wetland provides to local people and raised awareness of its importance. The results of the assessment were also communicated to other stakeholders and decision-makers, along with an economic evaluation of ecosystem services that was carried out with support from BirdLife Tokyo Office. This showed that Moeyungyi wetland provides US\$ 22.1 million/year of benefits, as well as US\$ 91.8 million of carbon storage function. This information was distributed to all stakeholders through pamphlets and leaflets. The management of Moeyungyi Wetland Wildlife Sanctuary was improved by using a zonal system,

raising awareness of school children and villagers through educational materials, monitoring and research, patrolling, law enforcement, celebration of World Wetland Day and the maintenance of the education center.

Introduction

Moeyungyi Wetland Wildlife Sanctuary is one of the 99 wetlands sites in Myanmar (Ministry of Environment Japan, 2004) designated as a Wildlife Sanctuary in 1988 with the sole objective of protecting the seasonal migratory and resident bird species as well as for conserving the ecosystem of the wetland habitat. People are settled in 17 villages around the wetland for many years. There are diverse terrestrial and aquatic animals, birds, insects and natural vegetation in and around the Moeyungyi Wetland Wildlife Sanctuary. The warm wetland habitat attracts various kinds of birds, including the migratory birds from the Arctic Region for wintering, which provides a good indicator of site significance. Moeyungyi is under those flyways acting as a crucial sanctuary for both migratory and resident waterbirds.

Moeyungyi Wetland Wildlife Sanctuary comprises a floodplain and storage reservoir that is important for flood control. Originally it was constructed in 1904 in the form of a rectangular man-made water storage reservoir by bunding to provide water to the Bago-Sittaung canal (linking

the Bago and Sittaung rivers) for transport of timber by boat. The site now functions as a source of freshwater for downstream areas where rice cultivation takes place. It floods in the wet season (May-October) and hosts over 20,000 migratory waterbirds from October to March. These include the globally threatened Baer's Pochard *Aythya baeri*, Sarus Crane *Grus antigone* and Greater Spotted Eagle *Aquila clanga*, as well as >1% of the regional population of the Northern Pintail *Anas acuta*. The site is also important for supporting the vulnerable Myanmar Eyed Turtle *Morenia ocellata*. The local communities use the site for fishing, grazing, duck-rearing and paddy

cultivation and there is a small tourist facility to accommodate birdwatchers. Moeyungyi Ramsar site No. is 1431 (MOEJ, 2004).

Location and Size

Moeyungyi Wetland Wildlife Sanctuary is located in the southern part of Bago Region; the western and southwestern parts belong to Bago Township and the southern and eastern parts to Waw Township. It lies between north latitudes 17° 30' and 17° 36' and between east longitudes 96° 33' and 96° 39' (Figure 1). The wetland covers an area of 40 square miles or 256,000 acres.

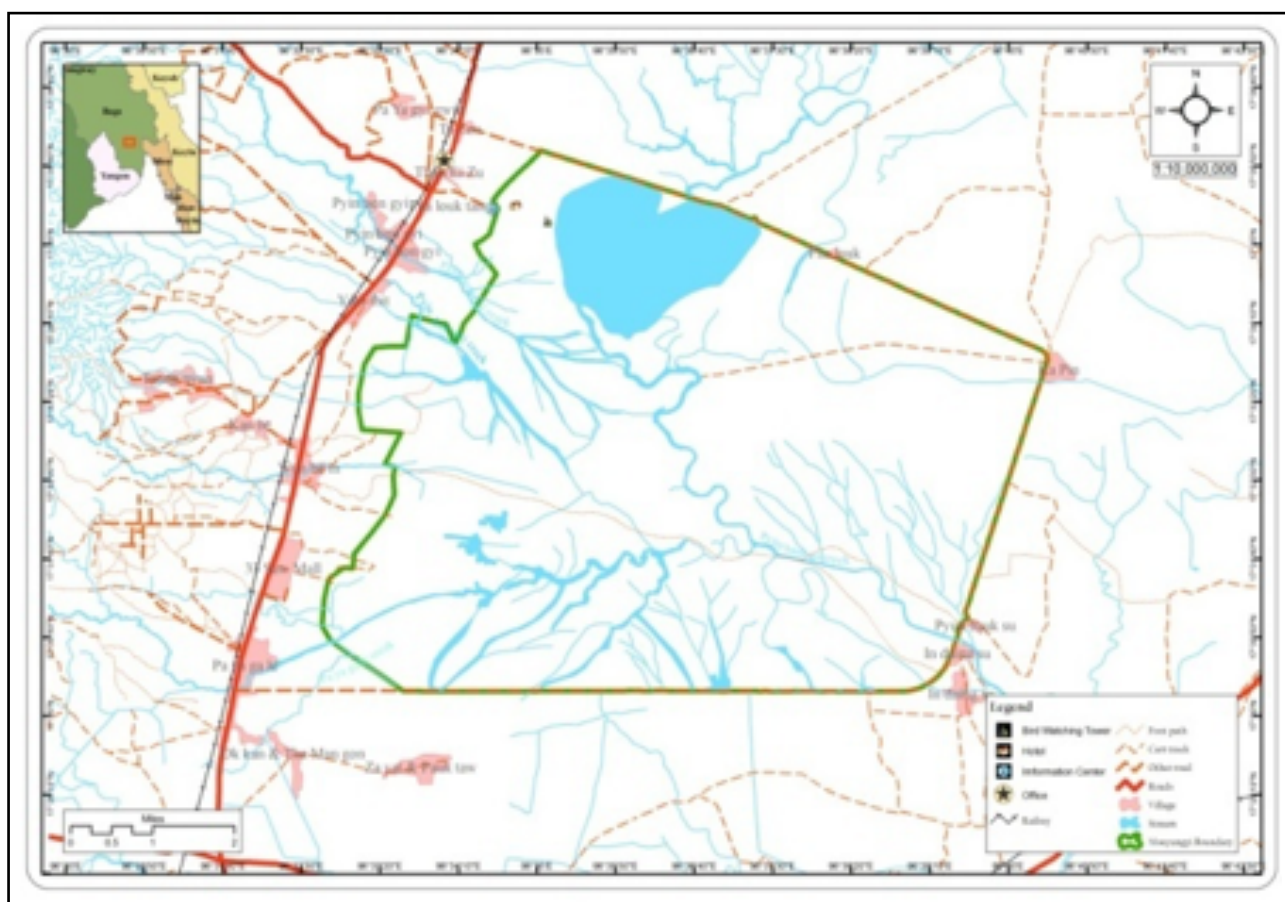


Figure 1: The Location of Moeyungyi Wetland

Baseline Survey on Biodiversity

Avifauna: During the survey, a total of 133 bird species were recorded out of which 1 was found out to be Vulnerable (VU) and 4 Near Threatened (NT) species (in a total population of 18,364 of birds). The large number of migratory birds can be seen here as they come here for wintering.

Mammals: A total of 12 mammal species belonging to 9 genera, 6 families and 4 orders were captured

and recorded. One species of insectivores, 4 species of bats, 1 species of carnivores and 6 species of rodents were recorded. According to the IUCN Red list (2013) there is no endemic or globally threatened species.

Herpeto Fauna: A total of 24 species of amphibians and reptiles were captured or observed (6 species of frogs, 1 turtle, 8 lizards and 9 snakes). According to the conservation status by the IUCN Red List (2013), one turtle

(*Moreniaoccellata*) was recorded as Vulnerable (VU), three species of frogs and five species of snakes as Least Concern (LC). Moreover, the turtle is an endemic species in Myanmar.

Flora: According to the IUCN Red list (2013) a total of 74 plant species belonging to (33) families were identified. There is no globally threatened flora species.

Fish: A total of 37 fish species were observed during the survey period. Altogether 37 species, 31 genera under 23 families were recorded.

Insects: A total of 41 different butterfly species belonging to 8 families and 89 genera under the order Lepidoptera were recorded. Nine families

consisting of 14 species of beetle were also recorded in the area during the survey period.

Issues and Threats: Major issues and threats were also recorded and ranked during the field survey. First the criteria for assessing the severity of threats and/or feasibility of addressing them were employed and then their ranks were determined. Using the Living Landscapes Program's criteria and ranking system, the total score for each threat was calculated using the equation: [Total= (Urgency + Recovery) x Severity x Proportion of Area affected x Probability]. Then the threats were ranked according to their scores. And the most important ones were identified for the conservation.

Table 1: Threats to the Sanctuary

Very High	High	Moderate	Low
Bird Hinting/Trapping with Nets	Invasive species	Insect catching using mist nets	Trapping small mammals for food
Electric Fishing	Use of fertilizers and pesticides	Indiscriminate dumping of solid and liquid waste	Infrastructures development (Resort)
Trading of Turtles and Snakes to China	Raising of Livestock	Flooding during the rainy season	
Land Encroachment (paddy field)	Water use	Fuel wood collection	
	Population growth		

Baseline Survey on Socio-Economic Status

The 8 villages around the wetland have 1,117 households of which 160 were selected as sample households to which the questionnaires were distributed according to the sampling numbers.

It represents more than 10 percent of the total households. The responses to 120 questionnaires were analyzed together with information from open talks and discussion with the local inhabitants.

Table 2: Socio-Economic Status of the Sanctuary (M= Male, F= Female)

Particulars	Waw Township				Bago Township			
	Tarkhwa	Hpalauk	Kapin	Punchaung	Pauktaw (or) Hlayseik	Hpalauktan	Thoneeinsu	Tarsone
Population	55 M=25 F=30	264 M=107 F=157	1741 M= 859 F= 882F)	1080 M= 400 F=680	95 M= 40 F= 55F	260 M= 120 F=140	1141 M= 551 F= 590	1285 M= 610 F= 675
Households	18	47	287	200	37	62	228	238
Building								
-brick				4	0	7	20	30
-wooden				75	2	30	30	100
-wood and bamboo				120	35	25	178	95

Education	-	Primary	Primary	Primary	-	-	Primary	Primary
Health	Pyinbongyi dispensary or traditional medicine practitioner in Kapin Village. For emergency or serious cases, Waw Township Hospital.							
Settlement Plan	On the shore of the wetland and villages are oriented towrds the shore.							
Recreation								
-TV	2	10	200	-	3	50	50	-
-DVD Player	2	-	-	-	-	-	-	-
-Satellite Dish	-	-	2	3 (1 Skynet)	-	5	6	-
Agriculture	11%	32%	61%	10%	5%	16%	13%	21%
Fishery	78%	60%	39%	85%	81%	76%	22%	14%
	18% of total fishery households practices electric shock fishing.							
Income and Expense	Daily Income				Daily Expense			
	26% - <3000 MMK				18% - <2000 MMK			
Size-120HH	58% - >3001 - <6000 MMK				64% - >2000 - <4000 MMK			
	16% - >6001 MMK				18% - >4000 MMK			
Energy	Electricity – 8%							
Size-120HH	Charcoal – 10%							
	Wood – 76%							
	Others – 6%							
Water Use	Tube well – 35%							
Size-120HH	Lake’s water – 13%							
	Wetland water – 52%							
Small Scale Industry	-	-	2 rice mills, ngapi industry	1 rice mill, ngapi industry	Dried pain industry	Cheroot industry	Cheroot industry, lotus textile industry	-
Sanitation Awareness	Fly-proof toilet – 28%							
Size-120HH								

Source: Biodiversity Assessment Study, 2014

Launching the Results of the Biodiversity Assessment Study

After conducting these baseline surveys, the multi-stakeholder was held in 2014 to make stakeholders aware of the threats facing the wetlands and the surrounding villages and its effects and determine main threats per subject (birds, insects, reptile, mammal, fish, floral and socio economic). All stakeholders were involved in developing solutions for the conservation of the wetlands.

Economic Valuation of Wetland Ecosystem Service

This report provides a summary of the valuation of a rapid ecosystem service provided by the Moeyungyi Wetland Wildlife Sanctuary, Myanmar's only Ramsar site. The purpose of this assessment is to raise awareness about the important economic and social values that wetlands, such as Moeyungyi, provides to people across all sectors and spatial scales. During the period of rapid developmental change in Myanmar, it is important that these non-market

values are recognized and incorporated into decision-making.

The values of the Moeyungyi Wetland Wildlife Sanctuary ecosystem services were first identified as the following and then quantitatively assessed under the current management regime.

- Agriculture
- Harvested wildlife good
- Climate Regulation
- Tourism/recreation

- Water
- Management cost

The overall net benefit generated from annual ecosystem service by the Moeyungyi Wetland Wildlife Sanctuary, minus management costs, is estimated at \$22,100,000 (\$2,130 per ha). The carbon stock is estimated at \$91,600,000 (\$8,840 per ha). The overall net benefit generated from annual ecosystem service (water for irrigation and rice production) associated with an increase in water use for irrigation, minus the management costs was \$245,000 (\$24per ha)



Fig 2. Preliminary scoping workshop (BirdLife)



Fig 3. Gathering of villagers for household questionnaire survey (BirdLife)



Fig 4. Reporting of results from the focus group discussions (BirdLife)

Upgrading for the Management

During the period of August 2015 to May 2016, the Nature Wildlife Conservation Division (NWCD) undertook a project named “Upgrading for ongoing management of Moeyungyi Wetland Wildlife Sanctuary, the first Ramsar Site in Myanmar” with a local organization, Biodiversity and Nature Conservation Association (BANCA). This project intended to support ongoing management of Moeyungyi Wetland Wildlife Sanctuary and ecotourism effectively by conducting monitoring, zoning demarcation, patrolling and law enforcement. The project mainly aimed at students, teachers and villagers

to motivate them to co-operate in conservation of birds and their habitats. The project teams have performed active consultation in 8 villages and attended by 966 school children, teachers and local people. The project objective was accomplished very successfully, and it is hoped that this endeavour will certainly motivate the local populace to realize the importance of wetlands and protect the environment for their wellbeing as well as future generations.

Conclusion

Myanmar currently has four Ramsar sites, Moeyungyi Wildlife Sanctuary and Indawgyi Wildlife Sanctuary, Mein Mahla Kyun Wildlife

Sanctuary and the Gulf of Mottama. Moeyungyi Wildlife Sanctuary is the first Ramsar site and also the site as Endemic Bird Area and Important Bird Area. People who have been living in adjacent area are mostly poor and lack awareness about the value of wetland that supported their daily livelihoods. For this reason, the staff of Moeyungyi Wetland Wildlife Sanctuary have been facing difficulties to manage the area.

The Nature and Wildlife Conservation Division (NWCD), Forest Department and Moeyungyi Wildlife Sanctuary took a leading role in these activities. The warden and staff played an important role to execute the project with the coordination role of local organization, BANCA, local authorities and village communities.

Reference

- Biodiversity and Nature Conservation Association (2014): Biodiversity and Socio-economic survey of Moeyungyi Wetland Wildlife Sanctuary.
- Peh, K.S-H., Merriman, J.C., Dae We Aung, T., Theint, S.M., Murata, N., Suzue, K. (2015) Economic valuation of Moeyungyi Wetland, Myanmar. BirdLife International, Tokyo, Japan.
- Yu, T.T, Kyi, S.W, Aung, T.D.W, Tun, T.A, Shwe, T.P, Win, H.T, Htet, M.T (2014): Upgrading for ongoing Management of Moeyungyi Wetland Wildlife Sanctaury, the first Ramsar Site in Myanmar.

Chapter 3:

Sustainable Uses in Nepal

Governance Plan for the Sustainable Management of Gaidahawa Lake Basin Area

Prava Pandey and Lanka Bahadur Shahi

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Abstract

Gaidahawa Lake (GL), a perennial freshwater body of 28.5 ha with greater than 34,560 ha basin area is rich in biodiversity. Political leaders and local communities have considered this lake as an area with huge potential for tourism and also can improve the surrounding biophysical condition of the Lumbini. The area deserves as next immediate destination choice for those visiting to the Lumbini. However, assessment study indicates that Lake Basin environment is under tremendous human pressure that results to reduced lake area, degraded water quality and high uncertainty of lake environment. Therefore, National Lake Conservation Development Committee (NLCDC) endeavored to assess and prepare a broader intervention plan of Gaidahawa Lake in the framework of International Lake Basin Management (ILBM) approach with keen interest of communities that indeed boost up to tourism, biodiversity and livelihoods in 2015.

This paper is the part of Management Plan of Gaidahawa Lake Basin Area prepared by NLCDC. The plan has explored activities in 4 components such as 1) Lake Basin Governance, 2) Lake Basin Environment, 3) Lake Tourism & Livelihoods, and 4) Lake Basin Management Capacity. The 1st component delivers semi-governmental institution to execute plan to restore, 2nd

component 'Lake Basin Environment' and 3rd component 'Lake Tourism & Livelihoods'. For all these, 4th component 'Lake Basin Management Capacity' builds technical, managerial and financial strength of institution and communities to integrate basin environment to tourism, biodiversity and livelihoods.

An estimated budget required for 10 years to implement this plan is NRs. 1,172,922 thousands. Of total about 3% is used for administrative >2% for lake basin governance, >32% for restoring basin environment, and >57% for creating tourism infrastructure which together also enhances climate resilient livelihoods and contribute to employment-centric and poverty reduction strategy of Government of Nepal.

Introduction

Gaidahawa Lake is a perennial freshwater body of 28.5 ha with greater than 34,560 ha basin area in Bishnupura, Rudrapur and Suryapura VDCs of Rupandehi district, Nepal which is very close to the Lumbini World Heritage Site, the birth place of the Lord Buddha (Figure 1). The land inhabits 20,951 populations in 3,120 households and hence the lake area has been subjected to encroachment by hill migrants of 80 households within 100 m perimeter of lake. Senior citizens claim that water body of GL used to be greater

than 80 ha in the past.

Lake is accessible at a distance of 15 km north of the Lumbini Cultural Heritage from Parsa Chauk intersection of the Bhairawa - Taulihawa highway; nevertheless, there exist many alternative access routes to lake area. Gaidahawa lake area is main attraction for domestic visitors because of the three main reasons.

(1) Its closeness to the Lumbini Cultural Heritage adds value to be the high potential area for national and international visitors visiting to the heritage site to spend leisure moment in lake for recreation;

(2) Habitat of Blue Bull: Community forest and national forests in Gaidahawa Lake Basin Area are principle habitat of Blue Bull which is an advantage for nature lovers and students to visit the area for educational purposes and

(3) Jatayu restaurant: community run Jatayu restaurant has created facilities for bird watching especially endangered vulture. There is practice of maintaining visitors register in lake area. The domestic visitors entertain the area during local festivals and holidays in the picnic spot of the lake area. 175 outsiders visited area especially for bird watching through Jatayu restaurant in 2010 (VDC profile 2010).

Besides, the lake is rich in biodiversity with 134 species of plant (51 families & 112 genus) including 6 species in IUCN Red List, 17 species of mammals, 95 species of birds (41 families & 71 genera), more than 26 species of herpetofauna and 18 and 7 species of local and exotic fish species, respectively. An endemic Indian-eyed Turtle i.e., Baldhyangre Kachhuwa (*Morenia petersi*) was reported the first time in 1995 from Sagrahawa Tal which falls within the basin of Gaidahawa Tal (NLCDC, 2017)



Figure 1: Gaidahawa Lake

GL area has high potential attraction for tourist as well as contributes to the biophysical surrounding of the Lumbini. The area deserves as next immediate destination choice for those visiting to the Lumbini. The management plan of Gaidahawa Lake found that the primary focus should also be done on tourism promotion activities to attract the national and international tourist of the Gaidahawa Lake Basin Area.

NLCDC under Ministry of Culture, Tourism and Civil Aviation (MOCTCA) is the only government authority in Nepal from 2007 established under the Development Committee Act (1956) for the

protection of Lake Basin Area. So far NLCDC has accomplished conservation programs in more than 226 lakes and wetlands of Nepal. However, these works are not enough for the conservation of lakes. Therefore, the committee has been emphasizing on conservation and development of the lakes located over seven provinces as the major tourist destinations. NLCDC facilitates the funds to the local conservation development committee, stakeholders, NGOs to conduct the various conservation and development reach programs to conserve the wetland biodiversity of entire Nepal. The funds are dispersed based on lake conditions, their significance, threats and

conservation status of lakes, daha, ponds and kunda of Nepal.

Tools/Approaches: NLCDC believes the import of the lake basins management in an effective and efficient way for the sustainable conservation of lakes and wetlands, the committee has been working on six pillars of lake governance in order to safeguard and manage the watershed of lakes that involve:

- **Institution:** to conserve and use the services of lakes and wetlands
- **Policy:** to control the consumption and minimize the impacts on lakes
- **Local people's participation:** to conserve watersheds of the lakes
- **Technology:** maximum use of technology in conservation
- **Education/Information:** use traditional and scientific education/ information system as needed
- **Sustainable economy:** an integrated economy to help in conservation activities

Integrated lake basin management (ILBM) is a comprehensive management tool that advocates on lake governance. It is a conceptual framework for supporting lake basin managers and stakeholders. It takes into account the biophysical features including lentic and lotic properties and the management requirements for Lake Basin system. It describes the inherent dynamics between human and nature in the process of development, use and conservation of lake and basin resources.

Good Governance Plan: NLCDC has prepared the Gaidahawa Lake Management Plan with ILBM approach with the integrity of ILBM pillars for the sustainable lake basin management.

Local Institution: Gaidahawa Lake Basin Conservation Committee (GLBCC) is the only organization of youth involved in conservation of lake that established Martyr's Garden on a principle of restoring lake. Its institutional, technical and financial capacity is very weak. Though involved in lake activities, its control over lake is either minimal or does not exist. Local

politics seems overriding the decision making of it. A governing institution is very much realized and demanded. Gaidahawa Lake Basin Area Council (GLBAC) shall act as regulatory body headed by DDC. This plan envisions the need of multi-stakeholder collaboration a mainstream development approach such as informative, inclusive, responsible, accountable and transparent vibrant community organization. Bishunapura VDC provides space for its secretariat in the premise as strategy to backstop and monitor daily administration (NLCDC, 2017).

Policies: GLBMC should register as certified non-political, non-profitable and civil society organization but backstopped by local government. It will be operated with independent program, administrative and financial policies (command and control) in harmony with prevailing acts, policies, and strategies of Government of Nepal (GoN). Policy should focus on sustainable lake environment with priority on biodiversity, tourism and climate resilient livelihoods including gender and social equity issues (NLCDC, 2017).

Participation: Being Lake under state ownership, government bodies at DDC and VDC levels should be counseling and monitoring. Creating linkages to the improvement of livelihoods of the local communities is a key to promoting participation in lake basin management and moving toward sustainable use of lake basin resources. Building the capacity of communities is essential to understand and appreciate local cultural belief, values and norms while managing lake basin for biodiversity, tourism and climate resilient livelihoods. Women play a central role in the provision, management, and safeguarding of water. Their participation in a full civil society, using a participatory approach and using culturally sensitive methods, will enhance efforts of delivering intended and successful results (NLCDC, 2017).

Information/technology: Both natural science and social science information are needed from the very beginning for lake basin management which forms the basis to formulate appropriate interventions; monitor and evaluate water quality, biodiversity and livelihoods; and share

learning based on science in different fora. Indigenous knowledge, along with scientific study and investigation, play a key role in Lake Basin management (NLCDC, 2017).

Finance: GLBMC should adopt a collaborative mechanism with local government for local fund from water users, fish levies, tourism and recreational facilities. Since local authorities represent in the GLBA Council, financing for capital infrastructure investments usually be ensured from these bodies. In addition,

GLBMC approach international communities for other fund, though international funding at most is catalytic. Plan foresees a provision of Communities' Lake Basin Green Cooperative' (CLBGC) to mobilize local fund from collective inputs and actions to involve each HHs of GLBAC to have shared fund for HHs economy. All financial transaction of GLBMC should be made from this cooperative. From the assessment, >2% of NRs 11,72,922 thousand is required to implement the good governance practice in Gaidahawa Lake Basin Area (NLCDC, 2017).

Impact of Human Activities on Lake Landscapes and Aquatic Fauna: A Case Study of Kechana Lake

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Abstract

Lakes are considered to be one of the most threatened of various major natural ecosystems and are claimed to deserve a highest priority for conservation and wise use. Kechana Lake is the **lowest land wetlands** of Nepal. Kechana and associated lakes lie in Jhapa district that are adjoining to the Indian border. It has a lentic environment. Kechan Lake is originated due to river process. Geographically it is known as Oxbow lake. This lake is Eutrophic due to the contamination with nutrient rich resources. The present status of faunal diversity surrounding the lake area is very poor. There are no trees, bushes and shrubs in the **lake periphery** and there is absence of aquatic weeds as well as floating flora on the surface water in the lake. These floras serve as food for aquatic fauna and make easier protect the aquatic ecosystem.

Introduction

Physical features of the land cover- in changes in a region, effects the ecological landscape functions and processes. Land use changes of the favourable climatic regions of the world are mainly caused by local people. Infrastructural development and economic activities are common reason for shrinking, degrading and disappearing wetlands worldwide. Lakes are inland body of water

that is surrounded by landmass is called a lake. According to Monkhouse, "The lake may be defined as a hollow, more or less extensive, in the earth surface which contains water". Lakes are those static bodies of water on the land surface which are surrounded by lands on all sides and are always located on the land surface (Singh, 2007). If we glance at the thematic map of spatial distribution pattern of lakes over the earth surface, there appears that they do not have any specific pattern of their distribution. Lakes occupy basins or hollow on the earth surface. There are two favorable conditions required for the origin and development of Lakes- (1) Suitable places where water may collect and may remain stationary, basins or troughs or depressions are the most ideal places for the development of lakes. The basin holds water and there must be a supply of water to fill the basin (2) The bottom of the basin should be below the outlet so long as the basin exists or there should be proper and regular supply of water, if the water table of ground water is higher than the beds of the basins, there is sufficient supply of water from underground sources.

Lakes are the most beautiful and expressive feature of the landscapes. They are often delineated as the "Eye of the Earth" and rightly so. Pristine, original and unchanged states of lakes reflect

the beauty, gladness and delight surrounding the environment. In contrast, polluted lakes are choked by callous dumping of waste like a blind eye.

Lakes are those ecosystems whose formation, processes and characteristics are determined by water and surrounding environment. These ecosystems are made up of the physical, chemical and biological properties contained within these water bodies. Bodies of lakes are diverse, in terms of physical, biological and socio-economic characteristics as well as geographical distribution. Lake ecosystems are influenced by their watersheds, the geological, chemical and biological processes that occur on the land and streams that lie uphill. The movement of chemicals, sediments, detritus, and of many organisms, is typically unidirectional from the watershed to the lake, but fish may migrate upstream, and aquatic insects may emerge and disperse on to land. A lake and its watershed are often considered to be a single ecosystem (Likens, 1985).

The concept of ecosystem services inspires human society to exercise a useful and practical perspective on lakes. The ecological structure and functioning of lakes provide wide ranges of services to local peoples. The services can be valued in formal monetary terms. These important values are scenic, cultural and biodiversity. Lakes are useful for drain and irrigate to catchments that have a land area at least as large as the lake and usually many times larger. The ecological conditions and the natural ecosystem services provided by a lake is affected not only by human activities but also by the morphology, the climate and the catchment of the lake.

Lakes are dynamic ecosystems with composite interactions between geomorphology, geology, hydrology, climate and biology in their entire drainage basins. They perform several hydrological, biological and ecological functions at the landscape and ecosystem level. They operate physical processes depending upon their nature, size, age, depth, location, deliver rate and catchment area ration of lake. Most oxbow lakes play a very significant role in groundwater recharge and flood mitigation in rainy seasons. Lakes are associated with several religious, socio-

cultural and economic functions of indigenous and local people. The function of lakes as ecosystems gives and support aquatic resources and services that are great value to the local and regional human societies. Lake water has been using for drinking since ancient times. Likewise, swimming, boating and irrigation facilities are also obtained from the lake water.

Almost all natural lakes of Nepalese Himalayas are still considered to be pure and sacred, and are used only for religious festivals and tourism perspectives. Most of the lakes of Hilly and Tarai Region in Nepal are in different states of degradation. Watershed diminishing is the most important cause of degradation of lake both ecological belts (Hilly and Tarai Region) of Nepal (Pokhrel, 1017). Degradation of watershed occurs by means of (through) deforestation; overgrazing; steep slope farming system in hilly region; slash and burn farming system in Churia region; intensive cultivation of Upper Tarai Region of Nepal. Similarly, urbanization and industrial allocation are other factors of shrinking and disappearing of lakes. Over the past few decades, lakes and wetlands of Nepal have become degraded, mainly due to rapid anthropogenic activities in their catchment environment.

Introduction of Study Area

Kechana Lake is a natural wetland that lies in the southernmost rural municipality of Jhapa district adjoining to the Indian border. It is situated 58 meters above the mean sea level. It is a lowest land lake of Nepal. The Lake (Jheel) is located at 26° 23' North Latitude and 85° east longitude. In ancient times, it was known as Rani Pokhari; however, since 1987 it is popularly known as *Kechana Jheel*. In the native language (Rajbangshi language), 'Kachan' denotes to the muddy area (*Kichad* or *Hilo*).

Kechana is an oxbow lake and is a remnant of an old river channel. The oxbow lake was formed during the shift of the river channel. It is also supported by the fact of location of another similar type of wetland in the southeast direction almost one km away which is known as *Khuttamani Jheel* (Figure 1). Both wetlands represent the channel of the old river. Soil types found within the wetland areas exhibit rounded

to the sub-rounded grain of sands and gravels, which are generally found in the river channels (Pandey, 2070).

Methodology

The study has covered the 70 households of surrounding area of Kechana Lake. The wetland was divided into two zones- one within 1 km around the wetland and the other of 3 km. Sample size was determined on the basis of statistical norms. According to the rule of thumb, if the size of sample is 30 or more, the distribution becomes normal and statistical test can be performed (Daniel & Terrel, 1995). Following the rule, a quota sampling of 35 households in each zone was randomly used for household survey. The study area of 3 km around the wetland was determined by the help of Topographical Map 1991. Purposive sampling technique has been used for qualitative data collection. Households for the interview were selected by the lottery method. Data were

collected from different Maps, Aerial Photos, Census Report, and Booklets. Data was analyzed and filtered as per need of the study. Sometimes, secondary data were supplanted by primary data in conventional and Meta form, which is directly collected from field observations, household survey and interviews. Topographical Map Sheet 72 N/ 10, 1959, prepared by Surveyor General of India was used to find out the settlement pattern of local people during the 1950s. Specific objective of the study is to assess the impact of human activities on lake landscapes and aquatic fauna.

Result and Discussion

The table 1 gives different impression of long-term population trends of the study area. The demographic phenomena reflect major types of influences surrounding area of Kechana. They are aquatic biodiversity loss, shrinking lake and changing lake landscape rapidly.

Table 1: Population Trends of Kechana

S.N.	Year	Population	Population growth rate (Inter Censual growth rate %)
1	1971	2870	Formula $r = \frac{Pt - Po}{Po} \times \frac{1}{t}$
2	1981	3517	2.25
3	1991	4420	2.57
4	2001	5360	2.13
5	2011	5957	1.11

(Source: CBS 1972, 1981, 1991, 2001, 2011)

Surrounding area of Kechana Lake was nature's paradise and luscious as well as delectable sight for naturalists. The periphery of the Kechana Lake was endowed with dominated by Sal forest (Sorriya robasta) before 1971. However, the late King Mahendra Bir Bikram Shah of Nepal had decided to resettle the Nepalese origin of Burmeli citizen expelled from Burma in the dense jungle area of Kechana by clearing the trees. Since that time (1967-1968), the wetland ecosystem and environment has been degrading slowly. Till 1981, most of trees of this area were cleared. Until 1986, reeds and shrubs covered the fringes of wetland and *Kechana Jheel* was very rich in biodiversity when it was undisturbed. During the referendum of 2036 B.S. (1979), a team of election campaigner visited the wetland in which the present researcher was also a part of that team. At that time, a fisherman caught 20 tortoises and

more than two kilograms fish fauna in an hour in front of us. This direct observation proved that it was one of the richest lowland wetland aquatic biodiversity of Nepal. It is reported that, till 1986 it was rich in aquatic biodiversity. Late King Birendra Birbikram Shah visited Kechana wetland on December 31, 1987 (B. S. 2044 Paush, 16) and addressed the local people and also awarded 4800 US Dollar (five lakh Nepalese Rupees) for properly maintaining the aquatic flora of the wetland. The King also ordered the ownership of the wetland to the native. He asked to remove the native and endemic fish species and to keep improved varieties of fishes instead. Before his visit, the wetland was known as 'Kuchi Khadi' low land and King Birendra renamed it as "*Kachan Kawal*" and now it is known as *Kechana Jheel*. It was noted and celebrated for its flora and fauna in the Jhapa District is now fast declining

its significance. The diminishing of the fauna and flora is due to utilization of the lake for improved variety of fish farming for commercial purposes by local rural municipality.

According to the cadastral map of 1964, the area of *Kechana Jheel* was 141,655 square meters. The wetland had provided an important feeding habitat for *Leptoptilos dubius*. The reptilian fauna includes two species of lizards (*Varanus bengalensis* and *Varanus flavescens*) which were found in a large number during that time. The wetland supports a number of aquatic and semi aquatic plants as well. The major floating plants comprised were *Nelumbo*

nucifera, *Gaertn* (Kamal), *Nymphaea nouchali*, *Burm. Alternanthera sessilis*, *Colocasia sculenta* (L.), *Schott and Eleocharis dulcis* (Burm.f.) and *Henschel* (IUCN 1992). Local people were using this oxbow lake for domestic use, plant harvest, fishing, aquaculture, grazing and fodder in the past.

The current state of floral diversity surrounding the wetland area is very poor. There are no bushes and trees in the wetland area. Absence of macrophytes is a major problem of this wetland because it provides food for aquatic fauna such as insects, fishes and waterfowls, wetland dependent birds and help to protect aquatic ecosystems.



Images of Kechana Wetlands

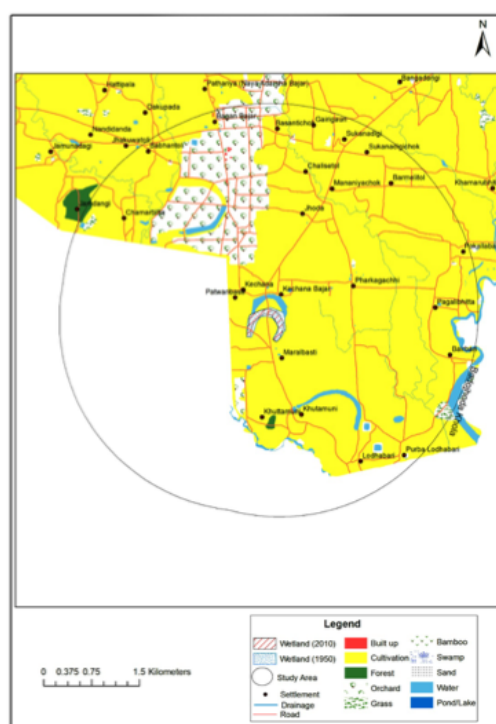


Figure 1: Location map of Kechana lake and Khuttamani Jheel

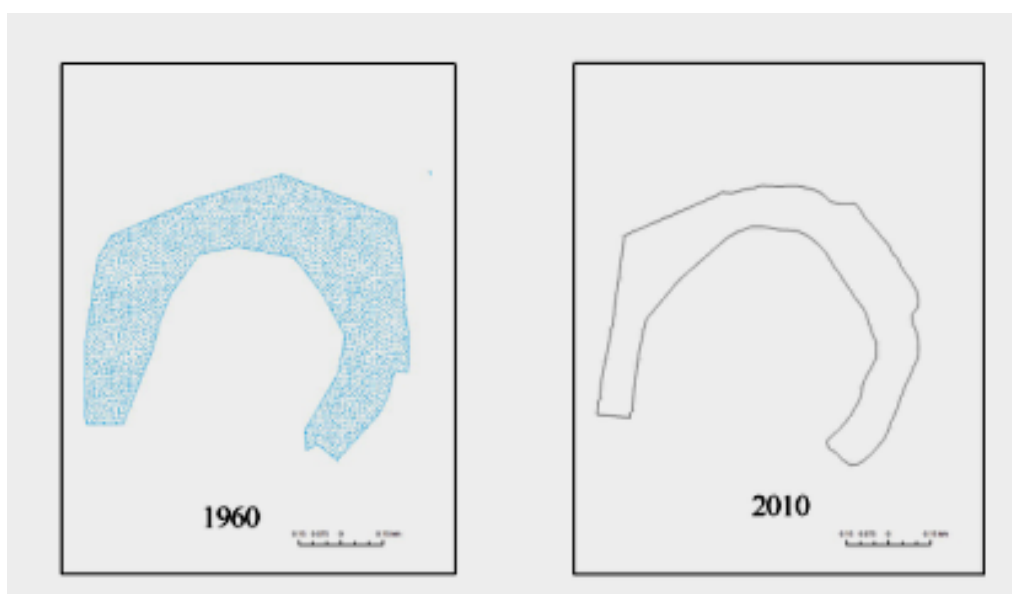


Figure 2: Kechana Wetland in 1960 and 2010

Clearing out the aquatic flora from the wetland is the main cause of degrading aquatic biodiversity in Kechana Jheel. Before 1985, there were abundances of local varieties of fishes such as Tengra (*Mystus Tengra*), Mungri (*Clarus batrachus*), Singhi (*Heteropneustes fossilis*), Eel, Kanti, Buwali (*Wallago attu*), Gaichii (*Macrogathus aculeatus*), Kabai (*Setipinna phasa*), Saura, Chuisii bam and Ballchuka. But today these local fishes are rarely seen. The wetland is now full of the introduced varieties of fishes such as the Big Headed Carp, Grass Carp, Silver Carp, Common Carp, Micra and Bhyakur (Shrestha, Bhattarai & Bhattarai, 2006). The introduction of these new species of fishes is the major factor in the disappearances of the native aquatic fauna of the wetland. Fish capturing by draining method, which is an unsustainable method, helped in diminishing the fish population from the wetland. Till 1970s, 40 households of the surrounding area had subsistence level due to fish. Until the 1980s, fishing activities has dominated the livelihoods of the indigenous peoples of the surrounding environment.

Kechana wetland covers an area of 92,482 square meters within 1, 2, 3, and 4 wards of Kechana VDC. The breadth of this wetland is about 50-60 meters. Some portions of wetlands are leased out to fish contractors by VDC office. The wetland is undergoing slowly ecological change by siltation, draining and domestic sewage. The wetland shrinking rate is 34.71 percent during last 50 years.

In other words, 806 square meters lake areas have been shrinking per year in periphery of Kechana wetlands. Some parts of the wetland area have been converted for subsistence agriculture land. Kechana and associated wetlands act a major source for balanced diet (protein and calcium) and livelihoods for hundreds of native people living in the surrounding area. The major source of natural spring of the wetland is Angulphuta stream and three natural springs, which were sources of water for the wetlands, have dried up.

The pathway of change is from wetland to agricultural use in Kechana wetlands. Wetlands are generally under public ownership. However, some parts of wetlands with public ownership have been converted into private ownership and utilized for agricultural and housing purposes. Agriculture has been the main cause of significant modification of lake landscapes on surrounding environment of Kechana Jheel.

Associated Wetlands of Kechana are facing terrible threats to their survival. Poverty and land hunger are the major pressing issues for Kachankawal Rural Municipality. There is limited assessment of numerous values and benefits provided by the wetland environment in the social ground. Wetland environment gives critical ecosystem services. Local public and private institutions as well as all political parties to address wetland issues devalurized these services but there is a lack of coordination and interaction among them. There is no documentation with

them on the comprehensive picture of wetlands and wetland resource available in their boundary.

Wetlands are precious elements of natural environment. In comparison to 1960, around 60 percent of wetland in the Kachankawal Rural Municipality has disappeared. Most of the wetlands will get disappeared after some decades, if the destruction of wetland environment continues in the similar way. The future generations will not see the aquatic environment and beautiful wetlands. Man has changed the morphology of wetlands and their surrounding areas by filling, damming and draining. The government should acquire the wetlands, marshes, quicksand and *Bhas* registered as the property in the name of individuals. The present wetlands found in the land survey are not found in cadastral map. They are being registered as individual's property. The buying and selling of land of wetlands are going on after they are filled for using agricultural purpose. Such activities should be stopped immediately along with the participation of local wetland dependent communities. According to qualitative survey (FGD, KIS HS and observation) the associated lake of Kechana has been polluting since 1971 due to intensive cultivation. Jute retting is a cause of degrading water quality and loss of endemic and indigenous aquatic of biodiversity. At that time Jute cultivation was the additional income of farmers and firewood, thatching materials for indigenous poor households' surroundings of Kechana Village Panchayat.

Lake receives nutrient entering with the run-off from the catchments. In rainy season, sky water run-off from the populated human settlement brings a various toxic substances and particulate matter. Soil erosion surrounding catchment area helped siltation in rainy season, due to high sediment rate. Siltation in Bed Lake by erosion is another serious problem of lake. Kechana Lake is affected by silt carried by surface water from their surrounding lands. Likewise, application of agro chemical in cultivated land, intensive agriculture system and open grazing activities are responsible for degrading lake. Imported improved variety of fish farming to maximize yields has been responsible for the shrinking degrading of natural lake ecosystem. It is main

causes of declining faunal and floral indigenous species.

Aquatic Faunal Resources

There are a lot of faunal resources like fishes, snails, shells and crabs. Some species of birds are very much dependent on wetland environment and they are considered here as wetland resources. In this study, only Lesser Adjutants are included.

Bhundiphor Garud (*Leptoptilos javanicus*):

It is a large wading bird in the stork family Ciconiidae, locally known as Bhundiphor Garud (Handiphor) (Image 1.1 - 1.2). Like other members of its genus, it has a bare neck and head. It is however more closely associated with wetland habitats where it is solitary and is less likely to scavenge than the related Greater Adjutant (*Leptoptilos dubius*). According to local people, there were Greater Adjutants until 1981. Now they are rare. Lesser Adjutant is an omnivorous largest aquatic bird. Foraging area of Bhundiphor is wetland environment. In the study area, they forage and fed on the open habitats such as marshes, swamps, oxbow lake and deep paddy fields. Lesser Adjutant generally searched food in motionless or slow-moving water. The favourable depth of water level was 40-60 centimeters deep with meager, weedy vegetation. During the prey time, they are standing without motion in the water body to capture prey that comes along by chance. When they finish surrounding preys, walks other place to explore the prey. The stork prey fish, Bam fish, frogs and reptiles, and water snakes. Storks generally feed more fish in wetland during the winter, whereas frogs and reptiles comprised a large portion of their diet during the summer. It nests colonially in large and tall trees, and historically on Simal trees (*Bambax ceiba*). It is categorized under critical, endangered (C I) species by the Red Data Book of IUCN (2004) and protected birds by His Majesty's Government of Nepal (2004). This stork is listed as vulnerable because it has a small population, which is rapidly declining.

Bhundiphor Garud is an important beautiful wetland dependent on large birds in nature. The shrinking of the wetland has affected it, its population and habitat. Its natural home is Simal tree around wetlands. 40 years ago, Simal

trees were in abundance and it is there that Bhundiphor Garuds developed their nesting colonies. But the situation has changed over the years. Table 1 shows the number of existence of Simal trees by year as reported by local people during Focus Group Discussion (FGD) in wetlands surrounding environment. There has been decreasing trend of existence of Simal trees in study area. More importantly, Kechana, where there were 31 Simal trees in 1963, but now is none. Decreasing number of Simal trees and shrinking of wetland have negative impact upon Bhundiphor. As a result, the population of Bhundiphor Garud has decreased. According to the local key informants, the Bhundiphor Garuds at the past were big and healthy but nowadays they appear like degenerated and look small, lean and thin during the foraging time in June and July. Till 35 years ago no cases of infant mortality of Bhundiphor were noticed but nowadays many chicks are found dead in their nests in the frontier zone of Nepal- India.

Until 1978, Simal trees grew safely in the study area. In a period of fifteen years (up to 1993), most of the trees were illegally cut down and taken away to match factories of Eastern Nepal. According to Local Key informants Simal trees

were also smuggling to the India during 1980s due to open border. Increasing trends of cutting Simal trees is the main factors of decreasing population of Lesser Adjutant. Simal trees and the population of Bhundiphor Garuds (*Leptoptilos Javanicus*) are decreasing in the same ratio. Therefore, habitat loss (destruction of Simal trees) is the main factors of decreasing population of Bhundiphor Garuds (*Leptoptilos Javanicus*). Geographically, market centers of Southern Tarai have experienced rapid decrease of Lesser Adjutant population. This has happened due to the lack of suitable trees for developing nesting colony among these birds. To protect the existence of Bhundiphor Garud (*Leptoptilos Javanicus*) for future, we should plant, grow and conserve the Simal, Karma / Haldu (*Adina cordifolia*) trees and wetland environment. Field observation, historical knowledge of key informants, quantitative and qualitative analysis proved Bhundiphor Garud (*Leptoptilos Javanicus*) and Simal Tree are good indicator change of wetland ecosystems. Decreasing trends of Bhundiphor Garud (*Leptoptilos Javanicus*), Simal Tree and shrinking / disappearing of wetland ecosystems are interrelated phenomena of wetland environment.



Image 1.1: Nesting colony of Bhundiphor (*Leptoptilos javanicus*)



Image 1.2: Bhundiphor Garud (*Leptoptilos javanicus*) is searching pray in wetlands

Loss of Fauna

In the past, before 1960s, there were enough dense aquatic vegetations and bushes and large tree like *Simal* (*Bombax ceiba*), where various wetland dependent birds were nesting. Wetlands were fully covered by aquatic birds as a flock. Due to deforestation, loss and deterioration of

wetland environment, many bird species have been disappearing.

Lesser Adjutant has been taken as an indicator of change in the bird's population and a brief description of such change is given below. Among the wetland dependent birds the population of Lesser Adjutant is decreasing rapidly (Table 1).

Table 1: Status of Lesser Adjutant and Silk Cotton Tree (*Bombax ceiba*) in Kechana Lake

Year	Decreasing trends of Fauna and Flora		
	Lesser Adjutant	Silk Cotton Tree (Simal)	Source
1963	75	31	FGD
1973	60	26	FGD
1983	50	24	FGD
1993	19	7	FGD
2003	20	1	FGD
2006	15	0	Point Count
2009	no nest, seen in June-July	0	Point count
2011	no nest, seen in June-July	0	Point Count
2016	come for foraging	0	Point Count

(Source: Field survey, 2010-2016)

In the past, before 1960s, there were enough dense aquatic vegetations and bushes and large Silk cotton trees (native name Simal tree = *Bombax ceiba*), where various wetland dependent birds were nesting. Wetlands were fully covered by aquatic birds as a flock. Due to deforestation, loss and deterioration of wetland environment, many bird species have been disappearing.

Lesser Adjutant has been taken as an indicator of change in bird's population and a brief description of such change is given below. Among the wetland dependent birds the population of Lesser Adjutant is decreasing rapidly (Table1). Bhundiphor Garud (Lesser Adjutant) nests colonially in large and tall trees, and historically on Silk cotton trees (*Bambax ceiba*). Before 1971, most of Silk cotton trees were related to their nests. At present most of Silk cotton trees have been fallen down.

Silk cotton trees in the surroundings of Kechana disappeared decades ago. They are disappearing in the surroundings of Kechana wetland. Now there are no habitats of Lesser Adjutant. During 1960s, there were 75 and before 1993, there lived more than 19 Lesser Adjutants. According to native key informants, they are shifted across the border when surrounding bushes were cleared out. The researcher observed this Lesser Adjutant on southern boundaries of Nepal (Pillar no 118 between Taatpauwa Village Panchayat of India and Jamdangi villages). Jamdangi is situated on the southern boundary of Pathariya VDC of Nepal and in the rainy season, they have been coming around Kechana for foraging. Another reason for the decline in the population of this

bird species is the use of its organs as medicine through poaching. According to Key Informants, there were some households involved in the hunting of this bird species before 2001 and who were using its organs as medicine. In developing market centers as like Kechana, where land acquisition and poverty reduction receive higher priority than environmental protection, wetland conservation is difficult if the local communities do not understand the value of the wetlands.

Since the wetlands, which were public lands in the past has been registered under private ownership, the landlords and land traders are more responsible in the shrinking area of wetlands. Moreover, the weak government policy and supervision with regards to the transfer of landownership rights is also responsible for it.

Lakes have been shown to play a significant role in biodiversity conservation. Lakes also provide various recreational outlets like as fishing, hiking and bird watching. Shallow lakes are seemed most productive biological systems. Irrigation by pumping of lake water for agriculture has been taking place dry cultivated land throughout the Jhapa District. Associated lakes of study area are the source of nutrients and enjoyment. In short, it is evident that the associated lakes lack adequate protection from continued degradation. Safekeeping of the lakes of the study area must be given high priority in our future indigenous aquatic biodiversity conservation.

Conclusion

Little area of the periphery of Kechana Lake has

been shrinking (806 square meters per year). That is 0.69 % per year. Agriculture has been the main cause of significant modification of lake landscapes on surrounding environment of Kechana Jheel. The wetlands in the south, where population density is low in its surrounding area, and are far from urban and rural market centers, are safe. There are limited effects of allogenic processes. Human economic activities commonly effect of the wetland resources. The wetland succession of Kechana is lower than the northern part of Jhapa district. Destruction of the wetland ecosystems is a serious environmental problem currently facing in the surrounding Lake Basin of Kechana Jheel. Lake receives nutrients entering with the run-off from the upstream catchments of Kachankawal Rural Municipality. In rainy season, heavy rainfall created deluge and runoff through the rural human settlements brings a various toxic substances and particulate matter. Soil erosion surrounding catchment area helped siltation in rainy season, due to high sediment rate. Siltation in Bed Lake by erosion is another serious problem of lake. Kechana Lake is affected by silt carried by surface water from their surrounding lands. Likewise, application of agro chemical in cultivated land, intensive agriculture system and open grazing activities are responsible for degrading lake. Imported improved variety of fish farming to maximize yields has been responsible for the shrinking degrading of natural lake

ecosystem. It is main causes of declining faunal and floral indigenous species of the lowest land wetlands of Nepal. Therefore, instant appropriate action plans have to be launched to conserve the wetlands biodiversity.

References

- Likens GE (ed.) (1985). *An Ecosystem Approach to Aquatic Ecology: Mirror Lake and its Environment*. New York: Springer-Verlag.
- Papastergiadou E.S., Retalis A., Kalliris P., Georgiadis T. (2007). Land use changes and associated environmental impacts on the Mediterranean shallow Lake Stymfalia, Greece. In: Gulati R.D., Lammens E., De Pauw N., Van Donk E. (eds) *Shallow Lakes in a Changing World*. *Developments in Hydrobiology*, vol 196. pp361-372, Springer, Dordrecht. <https://doi.org/>, 20July 2018
- Pokhrel, Puspa Lal (2017). *Wetlands of Jhapa and Morang Districts: A Study of Status, Dynamics, Utilization and People's Perception*. Kathmandu: Unpublished Doctoral Dissertation. Tribhuvan University.
- Sing, S. (2007). *Physical Geography*. Prayag Pustak Bhawan, University Road, Allahabad, India.

Present Status and Future Prospects of Ecotourism in Lake Rara

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Abstract

This paper describes indicator fish and wildlife in wild and scenic Rara Tal of western Nepal and discusses how this lake plays a significant role in sustainable ecotourism in Rara National Park. It makes valuation of wetland diversity and attempts to explain ways and means to integrate wild and scenic landscape, biological, ecological, spiritual and economic reasoning into wetland conservation and its best utilization. From the time immemorial large trans-Himalayan wetland as Rara Tal has great, religious and touristic value as staging area of many migratory birds. This is also the site of religious pilgrimage of intrinsic touristic win over psychic value. The future of biodiversity conservation and ecotourism development is intricately linked with conservation of fish and wildlife habitat and biodiversity of this wetland. So, the consideration of borderline habitat of endemic fish and wildlife habitat is necessary for wetland dependent terrestrial animals such as musk deer, red panda and others. This paper discusses specific problems of the conservation of Rara Tal particularly, water quality, quantity and biodiversity. It also identifies data gaps and provides recommendations for its conservation.

Introduction

Rara National Park is the gem-like national park of Nepal located in the Himalayan region of Mugu and Jumla districts. This park was established in 1976 AD and has the total area of 106 sq. km. It is an alpine magnet for tourists spotting more than 51 species of mammals and 272 species of birds, two species of reptiles and amphibians and three species of endemic snow trout fish.

Geological origin of Lake Rara is obscure and believed to have been formed as a result of river capture. It is supposed that the River Karnali once flowed through the Rara channel not as seen at present but north of it. The present Mugu Karnali, to the north of Rara, was at that time a separate tributary of the Humla Karnali. Later, after having its bed deeply eroded the Mugu Karnali was captured in the vicinity of Rara. In Lake Rara temperature varies according to the depth (Ferro, 1978). Water temperature from 0 to 14 m depth in June is 16.4 to 16.6°C. Below this depth a sharp gradient thermocline may be noted and from 50 m depth to the bottom the temperature is about 8°C. The dissolved oxygen gradually diminishes from 6 to 3.8 mg/l as one precedes sampling from 50 m to the bottom. This clearly suggests the breakdown of organic matter in greater depth and higher utilization of oxygen.

Methods of Study

To study wilderness ecotourism in and around the Rara National Park areas the authors visited the Park in 2017. Overall ecological, biological, social, religious and aesthetic scenario were recorded by direct observation and photographic records. Besides the hydrographic details of the lake, fish and bird habitats were photographed by underwater video camera with tele-lenses and polarized lenses. Local peoples, holy men, folk healers, witch doctors, musician, dancers and other social workers were interviewed. Data and information were gathered from direct observation, underwater-videography and literature review. Our observations are briefly presented below.

Wilderness and Biodiversity

The national park is the best place to admire and study major rare and endangered species of wildlife such as Himalayan black bear (*Ursus selenarctos thibetanus*), red panda (*Ailurus fulgens*), musk deer (*Moschus chrysogaster*), leopard cat (*Prionailurus bengalensis*), Assamese monkey (*Macaca assamensis*), grey wolf (*Canis lupus*) and so on. The park is also Eden especially during November and April when many species of these globetrotting species visit the Tal. The summer when rainfall is low, it is an ideal place for trekking. In winter, there is often snow on the ridge, surrounding the lake while in autumn, trekkers are rewarded with profusion of alpine flowers along steep walkways and wet meadows. The scenic vistas of the park are comparable to scenic beauty and bounty of Yorkshire dales of the United Kingdom and Yellowstone National Park, United States.

The present study shows that Rara National Park is also the prime habitat of endangered red panda (*Ailurus fulgens*). In 1979, three endemic snow trout species were reported from Rara Tal and are new to science. Also, in 1979, a frog species (*Paa rarica*) was recorded for the first time from the lake. Rara National Park harbours many species of rhododendrons. At present effort has been made for wildlife conservation, revenue generation as well as livelihood improvement for local people. Statistics show that the total number of tourists visiting Rara National Park was nearly

8,000 in the fiscal year 2015/16. Some more are expected this year.

Trekking Route

From Jumla, there are two classic trails to Lake Rara, forming a close circuit trekking of about ten days with sightseeing and relaxation at the Rara lake. One may enjoy wonderful sunrise and sunset from Lake Rara. Regular path heads west to Sinja, the cradle of Nepali language, and then proceed northwards. Several ridges are to be crossed before reaching to Rara. While returning, one must descend to Pina village from the Southern rim of the lake.

Culture

The age-old traditional cultural songs and dances allure tourists. The buffer zone area is suitable for people to launch different programmes like horse riding around the lake up to the Murma Top (3,600m), nature walk, cycling, migratory bird watching in winter and enjoying natural beauties and landscapes from the Murma Top (3,630 m), Chankheli Peak (4,201 m) and Chuchemara Peak (4,039 m). These eco-friendly nature activities would boost local economy by improving livelihood and providing employment opportunities. At the periphery and buffer zone of the park entrepreneurs and investors should be encouraged to establish eco-friendly hotels and lodges near Rato Pani (western part of the national park). Similarly, the practice of home stay facility could be developed in Amagaon and Ruga village far beyond the park. Mugu and Jumla districts are rich with traditional Nepali folk songs (such as *Deuda*, *Lokgit*, *Magal*), Buddhist culture and traditional attires.

Food Resource

People living in highland of Lake Rara relish original version of highland variety of rice used in past by royalties of Nepal. A wide varieties of rice and other cereals such as *Oryza sativa* (red rice, Jumli Marshi), *Eleusine coracana* (finger millet, Kodo), *Setaria italica* (foxtail millet, Kaguno), *Fagopyrum esculentum* (buckwheat, mithae phapar), *Fagopyrum tataricum* (buckwheat, tite phapar), *Hordeum vulgare* var. *nudum* (barley, uwa), *Panicum miliaceum* (proso

millet, chino) and green vegetables such as *Urtica dioica* (stinging nettle, sisno), *Amaranthus hypochondriacus*, *A. caudatus* and *A. cruentus* (amaranth, latte), *Phaseolus vulgaris* (bean, simi), *Arisaema flavum* (cobra lily, baanko) provide visitors gastronomic delight.

In future it will be worthwhile to find and relocate hotels and national park offices at suitable highlands away from the vicinity of the Rara Tal for up-keeping natural harmony. The government of Nepal must formulate formidable scientific policy for hotel entrepreneurs inside the park. There should be science-based publicity about the glory and grandeur of park. Therefore, all the park authorities and the stakeholders must give proper attention to the conservation of waterfront of the Rara Tal, pristine wildlife, flowering plant and marginal forest.

Many international tourists gather together to admire and study the sky-high wilderness of Rara National Park. This part of Nepal is dominated largely by religious and monastic environment. Local people and pilgrims love animal and advocate animal rights. Religious sentiment protects large segment of forest, river, lake including social, religious, aesthetic and academic value.

Staging Area for Migratory Birds

A large number of migratory water birds visit Rara from their breeding quarters in Central Asia, Siberia, Ladakh and other parts of Himalayas, northern and north-eastern India. During their annual migration, these water birds stop here for short periods of time to rest and feed that are essential for migration and crucial for their survival and well-being. Conservation of many and varied migratory water birds is thus directly linked to the conservation of our wetlands.

Rare birds such as Baikal teal (*Anas formosa*) and Mandarin duck (*Aix galericulata*) are mostly residents of far-off countries and come to Nepal only as "winter guests". We have moral responsibility to see that they return to their home safely. Loss of habitats through direct and indirect modification and non-sustainable utilization of waterbirds for human needs have led to the decline of several water bird species and number of species.

The wetlands are of great importance to mankind as it acts as the water reservoir for the world. It is also considered as the home for rare flora and fauna and is known to be the place of pilgrimage and the place of historical and cultural importance (Shrestha, 2007).

Beauty and Bounty of Lake Rara Forest Ecosystem

The ecosystem of Lake Rara is interesting. The edge of the lake is covered with blue pine (*Pinus excelsa*) and juniper (*Juniperus indica*). Then there is forest of *Abies spectabilis* and *Picea smithiana*. Besides, there are some patchy forests of bamboo (*Arundinaria*), rhododendron (*Rhododendron arboreum*) and *Salix daltoniana*. Lake Rara serves as typical Himalayan wetlands which house all representative plants and animals of the Himalayan wetlands.

The wind and wave tossed Lake Rara is a wintering spot for transHimalayan birds. Among waterbirds coot (*Fulica atra*), Crested grebe (*Podiceps cristatus*), Tufted pochard (*Aythya fulligula*), mallard (*Anas platyrhynchos*), common teal (*Anas crecca*), Bar-headed goose (*Anser indicus*), Brahminy duck (*Tadorna ferruginea*) are represented here. Among mammals, otter (*Lutra perspicillata*) Himalayan black bear, jackal, wild dog, wild boar and rhesus are well represented.

Assemblage of Aquatic Life

Lake Rara has unique assemblage of endemic fish fauna. Rara Black Snow Trout (*Schizothorax raraensis* and Nepal Snow Trout (*Schizothorax nipalensis*) and Large-eyed Snow Trout (*S. macrophthalmus*) are found in the lake. The former species up to the size of 33 cm has been caught. The stomach content of fishes showed *Gammarus pulex*, freshwater shrimp (*Penaeus*), Rams horn (*Planorbis*), snail (*Limnea*), Dytiscid beetle (*Dytiscidae*) and nymphs of caddies fly (*Trichoptera*) and Mayfly (*Ephemeroptera*).

Hydrography of Lake Rara

Lake Rara is one of the deepest lakes of Nepal. It is situated in the Mugu district of western Nepal at the elevation of 2,900 m covering 1583 ha. The turquoise lake on the lap of mountain offers breathtaking scene. Many crystal-clear

feeder streams such as Milichaur stream join the lake with teeming abundance of snow trout. The lake has single outlet Khatyad Khola which joins later the Mugu Karnali river at downstream. It is an oligotrophic lake. Water temperature of lake varies from 3 to 17 °C. Maximum depth is 167 m. Specific conductivity varies from 170 to 285 mohs. Average dissolved oxygen is 7.5 ppm. The lake provides three sub-habitats (i) Littoral (ii) Limnetic (iii) Profundal. Littoral zone is dominated by reeds (*Phargmites*), *Polygonum* and *Juncus* and Sedge *Fimbristylis* and Milfoil (*Myriophyllum*). Microflora are dominated by diatoms (*Amorpha*, *Cymbella*, *Navicola*) and green algae (*Cosmarium*).

The lake is a wintering place for the Bar-headed goose (*Anser indicus*), Brahminy duck (*Tadrona ferruginea*) and Great crested grebe (*Podiceps cristatus*). The feeder streams joining the lake harbor endemic Snow trout fishes and other ornamental fishes such as stone loach (*Schistura rupicola*) and sucker head (*Garra annandalei*).

The Healing Water of Lake Rara with Cosmic Power

Upon this spectacular high-altitude wetland site of religious importance, there is a belief among

people that one can watch his/her future and fortune inside the lake. There are many taboos and beliefs connected with this lake, which make it a pilgrimage area. The Rara valley is dotted with rangelands, wet meadows and half dozens of age-old temples of Lord Siva with full of wild flowers. Since this high-altitude wetland is not popular destination for tourists, the threat includes over grazing, unsustainable harvesting of medicinal plants and killing of wildlife during the extraction of medicinal herb such as Yarsagumba (*Ophiocordyceps sinensis*). Diverse species of endemic plants and flowers of high medicinal value are found in all high-altitude wetland along with the diversity of pristine Himalayan mammals including threatened red panda, musk deer and pikas. To generate authentic database, there is a need of long term research in Rara National Park. More scientific, religious, cultural, natural and historical importance of Rara must be explored. Since the Ramsar Convention on Wetlands is the only environmental treaty dealing with particular ecosystem, the government should also declare such sites as Ramsar sites beyond Rara near Humla to further support the conservation of high-altitude wetlands.

The real value of Himalayan wilderness and ecosystem can be realized visiting Rara National Park. Here, naturalist, philosopher and tourist may realize the value of solitude giving true sense of natural, spiritual and physical renewal. Perhaps for unspoiled wilderness there is no better illustration of value of naturescape of lake Rara than poetic sketches Late King Mahendra "In my experience, there is no finer temple than nature and man closer to his god when calmly enjoying glories and grandeur of enchanting scenery of great forest, high mountain, flowing river restoring tranquility of minds. A historical stone slab erected in flower decked meadow of Millchaur at the embankment of Lake Rara bespeaks these words.

Modelling Rara for Religious Ecotourism

Many factors contribute to determine the importance and character of Rara wetlands in the environmental sense and its pristine biological and historical values. These include geographic setting, the existence of biological phenomena, landscape, human presence and interference. Rara Tal is rich in biodiversity, beautiful and aesthetically appealing for tourists (Shrestha, 2007). It is not only an aesthetic fact; it has a role and purpose in the scientific, cultural and religious fields. The geographic position can affect the wetland's character and purposes differently. It is easy to see how the effect that wetland in high Himalayas

help moderating climate, agriculture and upkeep of the health of Himalayan environment. Lake Rara provides cover and shelter for rare and pristine animals like musk deer and diverse kinds of pheasants including Nepal national bird *Lohophorus impejanus*. This crystal-clear Himalayan lake is also known for their aesthetic and religious role especially to Hindus and Buddhists. Many devotees visit the lake to have holy bath and happen to see sometimes Lord Shiva's image reflected in the placid lake surface. Religious, recreational and healthy environment of the lake provides a natural stimulus for devotees and tourists alike.

“According to Hindu mythology, Lake Rara was created by lord Shiva. He shot his arrow into the mountain side to create a beautiful lake. At the same time, he shot another arrow to allow surplus lake water to run down as a stream. Since then it is regarded as the place of pilgrimage (or Tirtha Yatra in Nepali) revering its waters as holy and sacred. Waters of the Himalayan lake are revered throughout the Hindu world as divine being mixed up with life-giving substance. Since lake water is always mixed with soil leached with decaying Himalayan herbs is worldly alternative to elixir of the goods.

Potential Visitors to Rara National Park Enjoying Scenic Wilderness of the Lake

International Tourist

- Serious ornithologist

Ecotourism in Rara and Message for Tourists

(Note: RNP = Rara National Park)

Target Audience	Message
Visitors	
Serious ornithologist	Rara is a unique birding area
Naturalists/conservationists	Rara is an important religious site having age old temple, groove, aesthetic and inspirational value
Educated tourists	Rara is a unique paradise for birdwatchers, and fish watchers
Average tourist	Rara is an eco-centre imparting recreational learning experience
Youngsters	Rara is an open air natural history laboratory as seen from Murma top
Locals	
Students	Rara is Nepal's wetland heritage and Ramsar site with wet meadows, forest, pasture lands with life giving herbs
Teachers	Rara is an open-air classroom of nature covered with flowers, meadows, mountain pass with psychedelic blooms of rhododendron
Villagers	Rara is a source of crystal clear water and wave tossed sunny beaches entice boatmen, water sports such as boating and rafting
Administrator and political officials	Rara is a unique lake with teeming abundance of aquatic life including endemic snow trout and ideal sanctuary for unique fish in the world
Eco-Tourism Industry	Rara's high points and cliffs serve as natural fish observatory to observe frisking and frolicking snow trout a source of joy and wonder

Conflicting Interest of Management

In Rara ecologists may strike a compromise between many conflicting interests. These may include future viability of the habitat due to climatic change, the population and size of a species within a particular habitat, the welfare of individual, rare and endangered animals,

- Individual tourists
- Group tours (Educational including naturalist, philosophers, politicians and general)

National Tourists

- Serious bird watchers and professional ornithologist
- Elite educational groups (school and college students, teachers, wildlife biologists and professors on educational tour)
- General tourists (Family groups, conducted tours, religious tourists)
- Government officials (District administrator/judiciary, Members of Legislative Assembly, Members of Parliament, military personnel)

economic impact of management practices, the traditional interest of local ethnic human populace and others. Too often in other developing countries like Nepal, management decisions have been taken without adequate knowledge and understanding of aforesaid factors. So, these factors must receive special attention for future wildlife management

Safeguarding Rare Species from Extinction

Among Himalayan wetland lake Rara constitutes a treasury of immense value for mankind. The current alarming rate of species extinction is rapidly depleting this treasury in Nepal's Himalayas with potentially disastrous consequences. In the Himalayas, particularly in western Nepal nationwide conservation measures must be mounted to stem the tide of species extinction and should aim at species exploitation and human utilization. The objective of such effort is to determine suitable management practices by recording observable changes taking place in biotic and abiotic components of the ecosystem (Shrestha *et al.* 2017).

Lake Rara, one of the important wetlands in high Himalayas, provides the stage where wildlife resources and their users act and interact. The protection, enhancement and restoration of wetland habitat are fundamental elements of an endangered wildlife program (musk deer, Himalayan goat and antelopes). Some new threats to the integrity of Himalayan wetland habitats remain largely unexplored in Nepal. Therefore, wetland habitat templates are to be prepared for assessing the effects of novel threats.

Recommendation for Research and Innovation

1. Identification of core habitat for survival of rare and endangered species by undertaking long-term research and inventories;
2. Exploration of indices for rare fish and aquatic life and vanishing plant life, terrestrial wildlife and changes occurring in course of time;
3. Preparation of models for specific wetland habitat management for the rare and endangered wildlife species as musk deer which form a sound basis for the conservation of some other related species of animals;
4. Conservation of cultural taboos and belief of people and their ethnic diversity and ecological integrity.
5. Development of wilderness river park which may be feasible along the Mugu

Karnali to boost ecotourism. Encourage angling at riverside scenic waterscapes. Create terraria, vivaria, fish observatory and natural history museums outside the Rara National Park near Murma village. Promote birding, botanizing, butterflying and dragonflying activities in the park area. Popularize conservation of peripheral wildlife such as frogs, toads, voles, water shrews and insect life (such as beetles) for promotion of eco-tourism.

Recommendation for Special Research

- Explore and document zoological and botanical rarities of the Rara National Park and the adjoining Mugu Karnali watershed,
- Collect more authentic data of age old wetland heritage and socio-economic importance of river and lake with traditional fishermen's fishing experiences in the Mugu Karnali Basin
- Embark upon water sport promoting research related to public aspiration of boating and rafting in rivers and cold-water snow trout and mahseer farming
- Embark upon ecotourism promoting research based on recreational fishing and angling near verdant valley of Jhughala and Gamgad.

Much remains to be done for promoting ecotourism in Rara lake. The lake should be kept intact free from pollution. A holistic conservation and management scheme should be developed for the conservation of its biodiversity. For this both long-term and short-term programs should be developed. The short-term investigation program should, in general, aim at fostering ecological surveys and preparing inventories of the rare and vanishing wildlife distributed over the wetlands of various altitudes and ecological ranges. The long-term objective should be to study the species ecology, behaviours and population dynamics of the endangered plants and animals. Mugu and Humla districts should be made more accessible to local Nepalese tourists for the development of ecotourism.

Following are the conservation and management strategies for future:

- Maintain status of water quality and quantity in order to conserve pristine wildlife such as red panda, musk deer and endemic snow trout species of academic, cultural and game value.
- Protect lake from sedimentation and pollutants spilling from rangeland, agricultural land, adjacent village and human habitation. Protect cave, caverns and temple groves for the welfare of eagles, vultures and roosting bats.
- Protect the boundary of the lake from possible crack or burst from eastern side and havoc due to earthquake. Emphasize preventive measure to protect the lake from domestic detergents.
- Popularize fish and emphasize preventive measure to conserve lake fish, amphibians & otters living at the tail water of the lake and Khatayd Khola
- Embark novel type of wildlife conservation through education using media and religious teachers.
- Popularize ethnobotanical and herbal resources through the development of rare plant nurseries.
- Distribute publicity matters for stopping illegal hunting.

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References

- Ferro, W. 1978. Some limnological and biological data from Rara, deep Himalayan lake in Nepal. J. of the Nepal Research Centre 2/3, pp. 241-361. Tribhuvan University, Kathmandu, Nepal.
- Shrestha, T.K. 1990. Rare fishes of the Himalayan waters of Nepal. J. of Fish Biology 37: 213-216. Supplement. Academic Press, London.
- Shrestha, T.K. 1993. Status of Wetlands in Nepal Himalayas and Biodiversity, Geographer's Point, J. of Geography, Kathmandu, Vol. 2(1): 8-17.
- Shrestha, T.K. 1994. Fauna of Wetlands in Nepal. In: B. Bhandari, T.B. Shrestha and J. McEachern (eds.) Safeguarding Wetlands in Nepal. Proceeding of the National Workshop on Wetlands Management in Nepal. Kathmandu, IUCN Nepal. pp.41-52.
- Shrestha, T.K. 1995. Fish Catching in Himalayan Waters of Nepal. B. Shrestha, Kathmandu, Nepal. p. 247.
- Shrestha, T.K. 1996. Wetland Use, Habitat Fragmentation and Their Impacts on Turtles in Nepal. International Congress of Chelonian Conservation - Gonfaron, France, SOPTOM, editor pp. 57-61.
- Shrestha, T.K. 2001. Birds of Nepal. Vol. 1 and 2. Publisher, B. Shrestha, Kathmandu.
- Shrestha, T.K. 2005. Ecological Implication of tourism in Big game of Nepal Himalayas. XXVIIth Congress of the International Union of Big Game Biologists Hanover Germany 28 August to September Wildlife Management Congress. Hanover Germany.
- Shrestha, T.K. 2007. Present Status and Future Prospects of Ecotourism in Himalayan Wetlands of Nepal. In: Wetland. Debamitra Mitra (ed.) Wetland Conservation and Ecotourism South Asian Perspective. The Icfai University Press. Hyderabad, p. 162-180.
- Shrestha, T.K. 2017. Ecological Study of Fish Species at Rara Lake, Rara National Park, Nepal. A study report submitted to Department of National Park and Wildlife Conservation, Nepal Government.
- Shrestha, T.K., Shrestha, S.S. and Shrestha, A.K. 2017. Wilderness and Diversity of Life in Nepal's Chitwan National Park. B. Shrestha, Kathmandu, Nepal.

Emerging Issues and Challenges in Conserving and Developing Lake Cluster of Pokhara Valley

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Introduction

Wetlands are the link between land and water and are some of the productive ecosystems in the world. They are sometimes described as the "the kidney's of the landscape" because of their role in the hydrologic and chemical cycles. There are many kinds of wetlands and many ways to categorize them. All types of wetlands can be grouped into five categories. They are; marine (ocean), estuarine (estuary), riverine (river), lacustrine (lake) and palustrine (marsh). The functions of wetlands are to provide habitat for a wide variety and number of fauna and flora; to filter, clean, store water; collect and hold flood water; absorb wind and tidal forces and provide places for recreational activities. Wetlands are very important resources of the country. They play critical roles in human survival and development. These resources should be conserved and use sustainably.

The Convention on Wetlands, also called Ramsar Convention which was established in 1971 in Ramsar city of Iran for the conservation and sustainable use of wetland, has some 170 Contracting Parties and Nepal is one of them. Nepal is rich in wetlands which are found in the Terai, middle hills and high mountains. A survey shows that there are more than five thousand

wetlands of various sizes including lake, ponds and other wetlands in Nepal. Among these wetlands, few are listed as the Ramsar sites. Koshi Tappu is the first Ramsar site of Nepal which was listed in 1987. Ten wetlands covering 60,561 hectares are under Ramsar list whose details are shown in Table 1. These sites are under the management of different institutions such as Department of National Parks and Wildlife Conservation, District Forest Office and District Coordination Committee. The wetlands which are inside the protected area are managed by the concerned National Parks and those outside of the protected area are managed by the concerned District Forest Office but the Lake Cluster of Pokhara Valley is supposed to be managed by the District Coordination Committee of Kaski district and at this time there is a confusion as to who is responsible for the management of these lakes. The lake cluster of Pokhara valley has a strong basis for tourism development, biodiversity, ecological and socio-cultural importance. Efforts to promote and protect these resources against degradation, destruction and loss are under way. However, these lake areas and their watersheds have long been subjected to a number of emerging issues and challenges. These issues and challenges include unsustainable farming, soil erosion, land slide, encroachment of lake,

habitat degradation, illegal resource extraction, forest fire, pollution, unsustainable infrastructure development and climate change. However, the Government of Nepal has given importance for the conservation and development of wetlands by formulating National Wetland Policy 2003 and new Forest Policy 2014, but these policies

are not implemented properly in the field. This paper tries to integrate lake conservation and development activities in the watershed areas of the Lake Cluster of Pokhara Valley. Some pro-active measures that may enhance the sustainability of the Lake Cluster of the Pokhara Valley are also suggested.

Table 1: List of Ramsar Sites in Nepal

S N	Name of Wetlands	Area (ha.)	Year of Designation	Management Authority
1	Koshi Tappu	17500	1987/12/17	Koshi Tappu Wildlife Reserve
2	Beeshazar & Associated Lakes	3200	2003/08/13	Chitwan National Park
3	Ghoda Ghodi Lake area	2563	2003/08/13	District Forest Office, Kailali
4	Jagadisapur Reservoir	225	2003/08/13	District Forest Office, Kapilbastu
5	Rara lake	1583	2007/09/23	Rara National Parks
6	Phoksundo lake	494	2007/09/23	Shephoksundo National Park
7	Gosainkunda & Associated Lakes	1030	2007/09/23	Langtang National Park
8	Gokyo and Associated Lakes	7770	2007/09/23	Sagarmatha National Park
9	Mai Pokhari	90	2008/10/28	District Forest Office, Illam
10	Lake Cluster of Pokhara Valley	26106	2016/02/02	District Development Committee, Kaski
	Total	60561		

(Source: Department of National Parks and Wildlife Conversation, 2016)

Lake Cluster of Pokhara Valley

The Lake Cluster of Pokhara Valley is the beauty and ornaments of Pokhara. The cluster consists of nine lakes which lie in the northern foothill from east to west of the Pokhara Valley. The nine lakes are Phewa Tal, Kamal Pokhari, Gunde Tal, Khaste Tal, Neurani Tal, Depang Tal, Maidi Tal, Begnas Tal and Rupa Tal. The Cluster is designated in

the Ramsar list on Feb 2, 2016. This is the 10th Ramsar site of Nepal. The management plans of these lakes are prepared but not implemented presently. These lakes have separate watersheds. The sources of water for these lakes are streams, small creeks running from their watersheds and mostly fed by rain water. Pokhara receives highest rainfall in the country. The details of lakes and their watershed are shown in the Table 2.

Table 2: Details of Lake Cluster of Pokhara Valley

S. N	Tals	Altitude (M)	Watershed area (sq. km)	Water Area (sq.km)	Main Settlements in the Watershed Area
1	Phewa	762 to 2488	119	4.51	Panchase, Bhaure Tamagi, Kaskikot, Dhikurpokhari, Sarangkot and Pumdi Bhumdi
2	Kamal Pokhari	550 to 1439	1.2	0.02	Kanhu
3	Gunde	741 to 944	0.6	0.08	Jaldhera, Baranda
4	Neurani	744 to 863	0.2	0.02	Paite

5	Khaste	744 to 1192	2.7	0.09	Kandani Danda, Rakhi, Kalika
6	Depang	694 to 1266	2.4	0.06	Archale, Aarupata
7	Maidi	702 to 1102	1.6	0.01	Aarupata, Lamswara
8	Begnas	637 to 1439	18.4	3.27	Pachabhaiya, Beganas, Maghathana, Lamaswara
9	Rupa	590 to 1422	27.6	1.07	Rupakot, Kaure, Lipiyani, Begnas
		Total	173.7	9.13	

(Source: Department of National Parks and Wildlife Conservation, 2016)

The watershed area of the Phewa Tal is the highest among all other lakes. Neurani Tal has lowest watershed area. Similarly, there are many densely populated settlements in the Phewa Tal watershed area. In these lakes, there are also marshes areas. The water surface, swampy and marsh areas are shown in the Table 3

Table 3: Water Surface and Marshy & Swampy Areas of Lake Cluster of Pokhara Valley

S N	Lake	Water Surface (ha)	Marsh and Swampy Area (ha)
1	Phewa	506.4720	33.2080
2	Kamal Pokhari	2.2840	0.3150
3	Gunde	8.6480	1.1850
4	Neurani	4.1610	---
5	Khaste	137370	1.0170
6	Dipang	18.7500	2.8140
7	Maidi	0.8330	20.0990
8	Begnas	309.0200	3.2080
9	Rupa	121.7680	8.7560
	Total	985.6730	70.4740

(Source: Department of Survey Nepal, 2009)

Maidi Tal has very little water surface but a big swampy area. Neurani Tal consists only of water surface area with no swampy area. Phewa, Begnas and Rupa Tals have more water surface than their swampy and marshy areas

Conservation and Development Endeavours

The lakes of the Pokhara Valley were suffered very much from soil erosion and landslides from the watershed simply because of unsustainable farming and haphazard construction of infrastructure in the watershed. The government of Nepal initiated an Integrated Phewa Lake Conservation Program in its watershed for the conservation of lake in mid-seventies. This program was only focused for the soil and water conservation as a pilot project. A couple of soil conservation activities such as check dam construction in the gully and landslide area, and terrace improvement in agricultural lands and

conservation education were carried to reduce soil erosion. Similarly, a dam was constructed in the downstream of Phewa Tal to increase the water level of the lake, to irrigate agriculture land downstream. And also, a 100-kw power house was constructed. In addition, a dam was constructed in Begnas Tal to increase the water level in the lake and for fisheries and irrigation in downstream.

A couple of community forestry user groups were formed for the protection, development and proper utilization of the national forests in the watershed area. In this program some new forests were established, and existing natural forests protected. This program also enhanced the quality of the forest in the watershed areas. After the establishment of the National Lake Conservation and Development Committee (NLDCC), public awareness has been increased

for the protection and conservation of lakes of the Pokhara Valley. An integrated management plan also has been initiated but not fully implemented.

Pachanse is the important hotspot for socio-cultural values, biodiversity and permanent sources of water for the Phewa Tal. It is the highest point of Phewa Tal's watershed and one of the protected forests in the country.

Emerging Issues and Challenges

Efforts were concentrated for the conservation and development of the Lake Cluster of the Pokhara Valley in the past but not fully realized. The lakes are still facing different types of issues and challenges. They are briefly described below.

1. **Unsustainable Farming:** The people living in watersheds of all the lakes are dependent on agriculture and livestock rearing for their livelihoods. The agriculture land is used for growing mainly rice, millet, maize every year by tilling land. At the rainy season all the top soil is being lost due to heavy rainfall. The process is repeated every season. In this way the top soil reaches the lakes every year. Due to this reason, lakes are under threat. The number of cattle grazing in and around barren lands and forest also causes heavy soil erosions
2. **Encroachment of Lake:** The lakes are considered to be a common property, and nobody is responsible for the conservation and management of its resources. The land owners adjoining to lakes are free to extend their land towards lakes. Many property owners in and around lake are continuously encroaching the lake area. In this way the area of the lakes is reducing every year.
3. **Illegal Extraction of Resources:** Illegal extraction of forest products and poaching of wildlife still persists in the watershed of lakes, specially, in the Phewa watershed area. Illegal fishing in the lakes also frequently occur.
4. **Wildfire:** Wild fire is one of the major causes of forest destruction in the watershed area of the Lake Cluster of the Pokhara Valley. It destroys thousands of hectares of forest, flora and fauna every year.
5. **Pollution:** The Phewa and Begnas Tals are under threat to water pollution since many hotels and restaurants are located in and around the lakes. Boating is also another polluting agent in Phewa and Begnas Tals.
6. **Unsustainable Infrastructure Development:** The major challenge is the construction of roads using bulldozers in the watershed areas in the name of agricultural road, ring road, national roads without proper drainage system and without any proper soil conservation measures. The soil coming from these roads goes directly to the lake and deposit. This makes the future of lake in jeopardy.
7. **Climate Change:** Climate change is increasingly being recognized as a global crisis threatening human survival and biological resources. There is growing evidence that climate change, particularly increasing temperature is already having significant impacts on the world's physical, biological and human system. And it is expected that these impacts will become more severe in the future. This has led to the destruction of habitat, reduction of biodiversity and destruction of water sources as observed in the Annapurna Himalaya Range in western Nepal, close to the Pokhara Valley. The rise in temperature and change of rainfall patterns further illustrate the impact of climate change on wetlands biodiversity.

Recommendations

The Lake Cluster of the Pokhara Valley plays critical role in community's survival and development. It provides direct benefit as well as indirect ones such as socio-cultural and ecological values. However, there are many issues and challenges the lake cluster is facing. The following recommendations should address the issues and challenges to some extent.

- Local communities should be actively involved in the decision making, planning and conservation works, including development-related interventions. The traditional farming system should be shifted

by applying new tools and techniques and also adopt multi-year cropping so that their investment reduces drastically.

- Conservation education to urban and rural communities should be emphasized. Conservation education may help realign the people minds towards soil erosion
- A campaign should be set for the plantation of barren lands and either sides of the streams. It is necessary to build check dams in different sections of the streams so that soil from erosion will be blocked to reach the lake from the watershed.
- Promotion of bio-engineering and mechanical measures to control landslides, erosion and siltation.
- Poverty reduction needs income generation and employment creation activities in and around lakes which will help them to earn more money and the people will participate in conservation of lakes. An appropriate mechanism might be the establishment of cooperatives involving all the people in and around the lakes.
- All development policies, projects or programs should be subjected to Environmental Impact Assessment in order to identify their potential impacts. Proactive efforts should be made to restore the degraded or damaged watershed areas, which are preceded by the development activities such as unsustainable farming area, road construction and so forth.
- Encroachment of the lake must be reclaimed by detail cadastral survey with the consensus of the stakeholders concerned. The lake land and private land must be separated by fixing physical poles or signs in the field
- The hotel, restaurant and boat owners must be aware of pollution created by their different activities in and around the lake. Similarly, the paragliding company should make their activities environment-friendly

so that there will be minimum adverse impacts in the lake environment.

- The road construction should be minimized and must adopt soil conservation measures if it is necessary. The road construction must also be environment-friendly.
- The problem of climate change and its potential impacts on lake and its watershed areas should be addressed by the adoption of varieties of mitigation and adaptation measures. The measures include limiting or controlling anthropogenic activities such as deforestation, road construction, improper land management practices and changing energy technologies, ensuring proper fire management techniques in the watershed areas.

Conclusion

The Lake Cluster of the Pokhara Valley has very important role for the attraction of foreign and domestic tourists to Pokhara. Moreover, it is the biggest and latest Ramsar site of Nepal. If these prevailing challenges continue, the future of lakes will be uncertain and socio-economic condition of the people decline. A strong entity should be formed either by the Pokhara Metropolitan or Provincial Government to put on the ground, the mitigation measures contained in the Integrated Lake Conservation and Development Plan and ensure sustainable funding mechanism for the implementation of the Plan.

References

- National Wetlands Policy of Nepal 2003
- Forest Policy 2014
- Reports of Department of National Parks and Wildlife Conservation, 2016
- Department of Survey, Nepal, 2009
- Report of National Lake Conservation and Development Committee, 2007
- Integrate Lake Cluster of Pokhara Valley Management Plan 2016
- Website: natureconservation.pensoft.net/article1351

Implementation of Lake Cluster of Pokhara Valley Management Plan

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Abstract

Lake Cluster of the Pokhara Valley has international importance; it supports vulnerable, endangered and critically endangered species as well as threatened ecological communities. It is the 10th Ramsar Site of Nepal, declared on 2nd February 2016. The lake cluster consists of 9 lakes of Pokhara valley. Despite the socio-cultural and biological importance, the lakes are facing different threats such as eutrophication, sedimentation, encroachment/agriculture land expansion, pollution (Solid waste), commercial fishing, aquatic species invasion, excessive tourism pressure, livestock grazing, urbanization/settlement expansion and infrastructure development. Considering the need of immediate response and high biodiversity importance and major threats/vulnerabilities, the stakeholders meeting held under the chairmanship of Local Development Officer, Kaski has decided to focus the sustainable management activities in Khaste Nureni and Gunde lakes. Different wetland restoration activities such as dykes construction, Salix plantation, cleaning campaign, outlet regular construction, fish farming support and wetland orientation have been carried out in and around these lakes.

Key Words: Lake Cluster, Pokhara Valley, Ramsar, Aquatic

Introduction

In many respects, wetlands are amongst the most productive ecosystems in the world. In Nepal, they occur in diverse ecological zones from high-land Himalayas to low land Terai. In 1988, Nepal became a signatory to Ramsar convention which highlighted Nepal's commitment to conservation of wetlands. However, the wetlands had been a neglected for long even though they have social, economic, religious, and touristic significances.

Lake Cluster of Pokhara Valley (LCPV) is a cluster of nine lakes in Pokhara valley (Phewa, Kamalpokhari, Gunde, Khaste, Neureni, Dipang, Maidi, Begnas, and Rupa). The major threats enlisted by the vulnerability assessment of these lakes include encroachment, siltation, pollution (fertilizer, manure, and pesticides from upstream), and invasive species. This lake cluster was declared as Nepal's 10th Ramsar Site in 2016. This was followed by preparation of Integrated Lake Basin Management Plan of LCPV (2018-2023) which was recently endorsed. The Management plan of LCPV is likely to foster the coordination and resource leveraging among stakeholders for addressing the threats to improve the Lakes' ecosystem.

Habitat Assessment

Habitat Assessment of wetland birds and impact of removing aquatic plants on bird was carried out

through technical support of Pokhara Bird Society. A total of 101 species of avian fauna from 35 families were recorded from Khaste, Neureni and Gunde lakes by using direct observation method at different vantage points (Figure 1). A total of 33 species of water birds, 14 residential and 19 migratory birds were recorded. Among them, Waders were 17% followed by Swimmers 10%, Aerial Forgers 4%, and Divers 2 % (Figure 2). Six globally threatened species including 3 critically endangered (Slender-billed vulture, White-rumped vulture and Yellow breasted Bunting), 2 endangered (Egyptian Vulture and Steppe Eagle), 1

Vulnerable (Woolly-necked Stork) and one Endemic species (Spiny Babbler) have been found in the Pokhara Valley Lake Cluster. Among the water birds, maximum number encountered were swimmers viz. 308 followed by waders 180, divers 116 and aerial forgers 7. Some of the birds were found breeding namely Cotton Pygmy-goose, Lesser Whistling-duck, Little Grebe, Common Moorhen, Eurasian Coot, Bronze-winged Jacana, White-breasted Waterhen, Cinnamon Bittern and Yellow Bittern (PBS 2017, unpublished). In total, 14 migratory and 19 residential birds found were in three lakes.

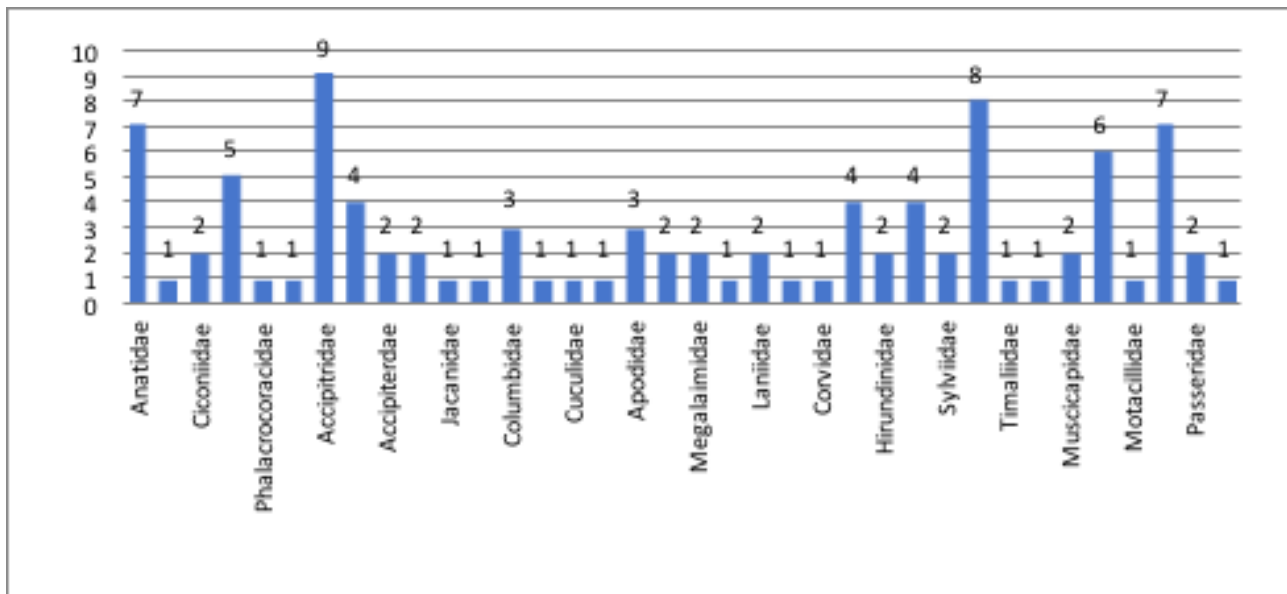


Figure 1: Total number of families and species of birds in Khaste, Neureni and Gunde lakes of Pokhara

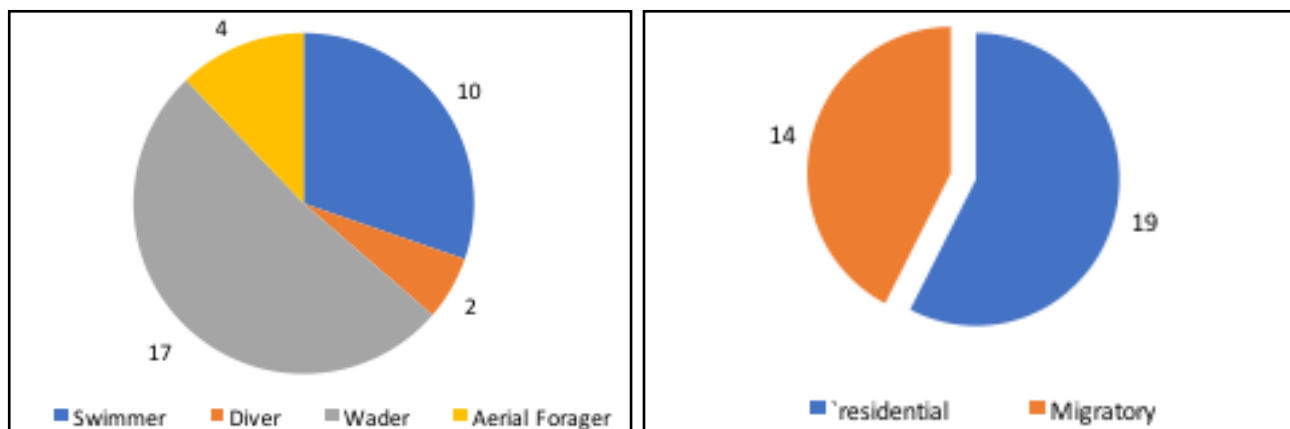


Figure 2: Migratory and residential birds (left) and Number of water birds of different categories (right) in Khaste, Neurini and Gunde lakes

A total of 71 species of terrestrial vegetation recorded around 10 m periphery of lakes. Similarly, 18 species of aquatic plants were recorded including floating and submerged plants (Source: Habitat Assessment report supported by WWF Nepal, Hariyo Ban Program 2018). This study has provided some recommendations such as, cleaning of wetland with 50:50 mixtures of open water and emergent vegetation to maintain high species richness and diversity of water birds is necessary and should be considered while carrying out conservation work in the lakes. Total cleaning of vegetation is strictly discouraged. Cleaning should be carried out along the dykes and edges completely with cluster cleaning. Vegetation should be maintained in Khaste Lake. Depth (water level) of the lakes should be maintained at least more than 4 meters overall season.

Intervention for LCPV Protection

Hariyo Ban Program has been working closely with the Lake Management Coordination Committees to implement priority activities as envisioned by the management plan. Different initiatives such as landslide stabilization, bio-engineering, sediment trapping measures and plantation in six sites of Upstream of Khaste and Neureni lakes were completed to conserve 1.30 ha

of degraded land. These initiatives are aimed to reduce sediment flow into the lake systems. Furthermore, 250 meters of dyke was constructed, and two boats were provided to remove the invasive plants in Khaste.

Likewise for livelihood promotion, 5,000 fingerlings of native species are being farmed under the program support. Similarly, two breeding and rearing cages of 50 sq. m with capacity of rearing 20,000 fingerlings were set in Khaste to contribute to the livelihood of the people living in the area. After installing rearing cage in Khaste lake, 50 percentage cost has been saved for buying of fingerlings, leading to fish farming at commercial scale.

750 meters long trail linking the Gunde, Khaste and Neureni has been constructed, which has significantly improved eco-tourism potential of the three lakes. About 400 *Salix* cuttings were planted along the lakes bunds to promote greenery and beautify the lake environment. An outlet regulator has been constructed in Gunde to regulate the water volume in the Lake and fulfil water requirements downstream. All these interventions have contributed to conserve about 348 ha of watersheds indirectly (Figure 3).



Figure 3: Different restoration activities in Khaste, Niureni and Gunde lake

Outcomes of Intervention Activities

Wetland protection activities in Khaste and Niureni have been conducted through Machhapuchhre Development Organization, Kaski. Through implementation of different conservation activities, 26,160 ha of biologically significance areas is under improved natural resource management and approximately 348 ha of biologically significance area is showing improved biophysical condition through different activities such as dyke with foot trail about 250 meter, plantation at degraded land in upstream and 563 *Salix* plantation

at lake shores, landslide protections and foot trail, outlet regulator, five check dams, low cost soil technology (wattling) to stabilize landslide sites.

The communities have already started fish farming in Khaste and Niureni lakes through establishment of fish cooperative. The program has also supported to release 7000 fingerlings. Total fingerlings included Rahu-1000, Naini-1500 and Silver carp-4500. These fingerlings were purchased from nearby private hatching center. This cooperative has harvested fish every week ranges from 25 Kg up to 150 KG through using these boats.

The cooperative has earned NRs. 7,00,000 from fishery. The profit amount from this fish farming has been utilizing in the conservation actions such as fencing and remuneration of lake guard.

Altogether 133 participants including 68 females capacitated on better understanding of conceptual clarity on importance of wetlands, prevailing policies, threats and vulnerability of respective lakes and prepared the action plan for wetlands conservation through organizing two events of wetland orientation. The Program has been continuously supporting communities and local government to implement priority activities identified by the LCPV management plan. The program has also planned to work in three more lakes i.e., Maidi, Kamalpokhari and Phewa. So, lakes restoration and livelihood improvement related interventions will be implemented altogether in six lakes through the support of Hariyo Ban Program in order to protect and provide economic benefits to the people. Sediment retentions/ removal work, 600-meter dyke's maintenance, two events of orientation on wetland conservation, induc-

tion of 4 boats, removing aquatic weeds through hiring two human resources, bamboo and broom grass plantation, coordination meeting of all stakeholders and micro watershed management in Phewa are some important planned activities on these six lakes. In the long run, these initiatives are expected to improve the ecosystem services, such as ground water recharge, ecotourism promotion, improvement of local livelihoods, biodiversity and water supply downstream, leading to a more balanced ecosystem.

Conclusion

Sedimentation is major threat to Khaste and Nureni Lakes due to haphazard construction of earthen roads and felling down of mother trees around the lakes. Sedimentation is major reason for shrinking of lake and deteriorating water quality. In addition, landslides seems more vulnerable and expanded towards the human settlement. Hariyo Ban Program had been supporting to protect the landslide, gabions along with broom grass and bamboos plantation with focus on improvement of livelihood of local population.

Conservation Value of Beeshazari Lake: An Insight into Diversity of Water Birds

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Abstract

Beeshazari and associated lakes, a globally significant Ramsar site, play the vital roles in providing feeding and breeding grounds of a large number of wetland fauna including birds. Present status and conservation threats of water birds were studied by using Area search (AS) and Scan sampling methods in and around Beeshazari lake system. We recorded a total of 913 individuals of water birds belonging to 44 species, 9 orders and 11 families during winter and summer seasons of 2017. The species diversity of water birds was more in winter ($H=3.423$) than summer season ($H=2.91$). However, the species dominance was low in winter ($D=0.399$) than summer ($D=0.072$) indicating more diversity of water birds in winter ($1-D=0.96$, $J=0.921$) than summer season ($1-D=0.921$, $J=0.893$). Fishermen ($R^2=0.058$, $F=3.591$, $P=0.0001$) and tourist pressure ($R^2=0.127$, $F=2.535$, $P=0.002$) caused the significant negative impact on the occurrence of water birds in many parts of the study sites. Wetlands of Beeshazari lake support a total of 13.5% of globally threatened and 10.06% of the nationally threatened birds. The major threats to water bird communities in

Beeshazari lake system were human disturbance (e.g., tourists and fishermen), habitat loss and degradation (e.g., damage of dams of lakes), declining water quality and quantity caused by eutrophication. Therefore such threats need to be addressed for the long-term survival of the water birds and also to increase the conservation value of this lake system.

Keywords: Beeshazari lake, Water birds, Wetlands, Bird conservation

Introduction

Nepal, the Himalyan country, supports 887 species of birds (8.87% of the global bird species) due to its landscape heterogeneity (DNPWC, 2018). Among them, 37 are globally threatened species, 19 near threatened species (DNPWC, 2018; IUCN, 2018). Due to habitat shrinking and eutrophication in wetlands more than 15% of the total birds (130 species) have enlisted in nationally threatened category (Grimmett et al., 2016).

Wetlands play the key roles for providing feeding and breeding places of a large number of threatened fauna including birds (Parchizadeh & Williams,

2018). Wetland birds play vital role roles in many aquatic ecosystems such as predators, herbivores and vectors of seeds, invertebrates and nutrients. Wetland birds are the bio-indicators of ecological condition and help to control the pests (Green & Elmberg, 2014). Freshwater wetlands hold more than 40% bird species of the entire world (Inskipp et al., 2017). Wetland of Nepal supports a total of 27% of nationally threatened birds (BCN, 2018). Five percentage of total area of Nepal is covered by water resources (Mandal et al., 2017). Ten globally significant wetlands of Nepal are declared as Ramsar sites that occupy 60,561 ha area (NLCD, 2018). About 0.5% of the total area of Chitwan National Park is occupied by wetlands having area more than one hector (except rivers and streams) (CNP, 2014). Beeshazari lake is one of them which is located inside the Barandabhar corridor, one of the important bio-corridor that connects world heritage site Chitwan National park and Mahabharat range.

Materials and Methods

Study area

The Beeshazari and associated lakes lies in Barandabhar Corridor (BC), an important wildlife corridor that connect Chitwan National Park (CNP) with Mahabharat range in the north and Valmiki Tiger Reserve, India in the South (Thapa, 2011). This lake system is surrounded by seven bufferzone community forests (BZCF) (CNP, 2017). Beeshazari and associated lakes, a Ramsar site covers 3200 ha area (Figure 1) that consists of Satrahazari (27°37'06.3"N, 84°27'10.4"E), Kumal Lake (27°36'52.3" N, 84°28'20.4" E), Beeshhazari (27°37'04.6"N, 84°26'11.3"E), Athaishazari lake (27°36'38.7"N, 84°25' 03.2" E) and other small lakes (Bhuju et al., 2007). This lake system is an extensive typical oxbow lake system of the inner Terai that provides excellent habitat for many endangered fauna as a waterhole and corridor (Zhu et al., 2015).

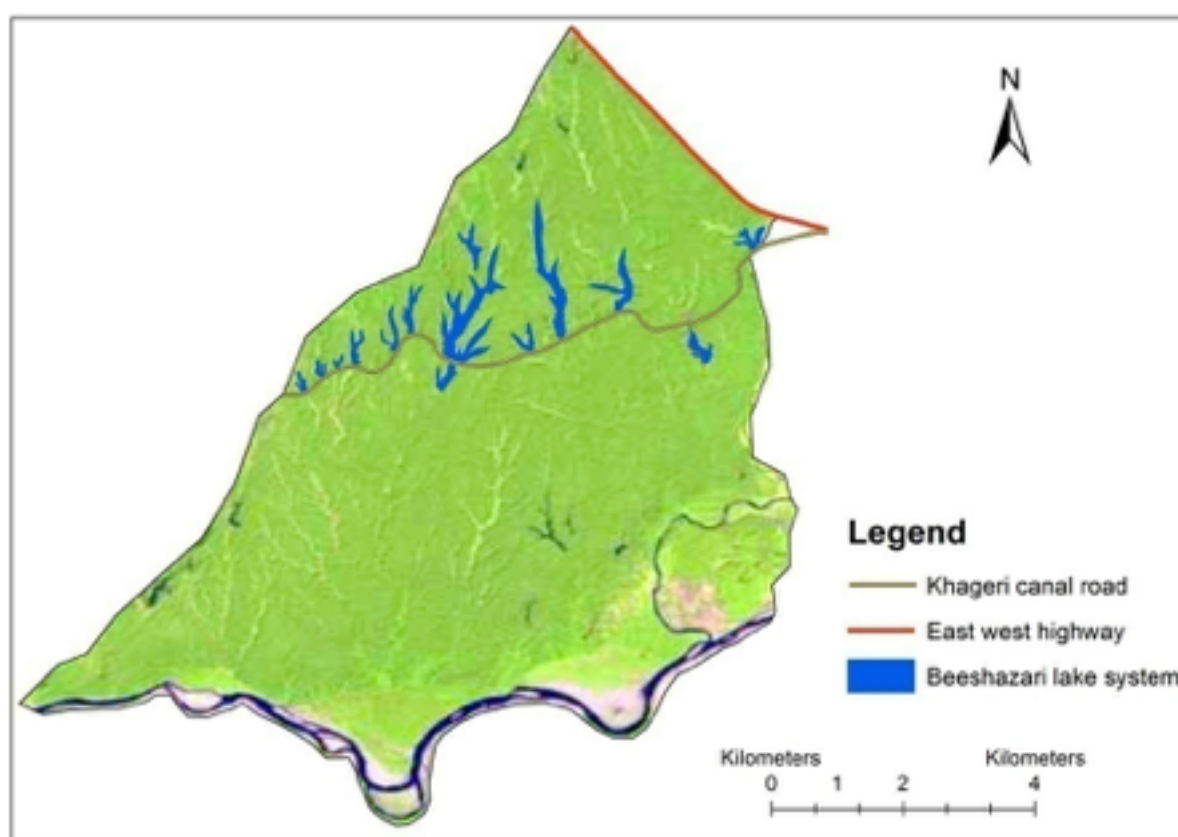


Figure 1: Map of Beeshazari lake system: the lakes round the Khageri canal system are called Beeshazari lake system

Beeshazari lake system is surrounded by more than 199 species of vegetation including 17 species of Graminae and 13 species of Leguminosae family were recorded from the area (Gilani et al., 2017).

Data collection

The wetland birds were surveyed using Area Searches (AS) and Scan Sampling methods during two seasons (winter and summer) in 2017. All the lakes of Beeshazari lake system were considered as hotspots areas and used for the monitoring of wetland birds in two seasons (winter and summer) (Bibby, 2000). Direct observation method ("look-see" counting method) was used to identify and record the individuals of bird species. In each lake, certain points were fixed at its periphery for bird watching with the help of binoculars (Dahal et al., 2015). During the survey, the number of individuals, associated habitat types, human disturbance indicators such as number of tourists, number of fishermen etc. were recorded. Birds were monitored early in the morning from 6 AM to 12 AM and in the evening from 3 PM to 6 PM.

Data Processing and analysis

The seasonal diversity of the wetland birds, diversity indices include Simpson's dominance and diversity, Shannon, Evenness indices, Jacob's Equitability index were determined in PAST V 3.18 (Hammer et al., 2001). Further analysis was performed in S-Plus. We identified the threatened status (globally and nationally) of the birds by

using IUCN red list and National Redlist Data Book (NRDB) (Grimmett et al., 2016).

Results and Discussion

Diversity of wetland birds

A total of 913 individuals of wetland birds belonging to 44 species, 11 families and 9 orders were recorded in Beeshazari lake system in 2017. This study showed that Anseriformes had highest number of species (13 species) followed by Pelecaniformes (11 species), Coraciiformes (6 species), Gruiformes (5 species), Ciconiiformes (3 species), Suliformes (2 species), Accipitriformes (2 species) Podicipediformes (1 species) and Strigiformes (1 species) (Table 1). Khadka et al. (2017) reported 46 species of wetland birds in Rapti and Narayani rivers. Bhattarai (2012) reported four species of storks in BC. Similarly, wetland bird study carried out in Phewa lake found 39 species of wetland birds (Giri & Chalise, 2008) and 36 species of wetland birds were recorded from Rupa lake (Kafle et al., 2008). Chhetri (2006) reported 98 species of wetland birds belonging to 60 genera and 18 families around the Koshi barrage area. Thapa & Saund (2012) reported a total of 77 bird species representing 8 orders and 31 families in Jagadishpur reservoir. Hence, present study shows that Beeshazari lake system supported more species of wetland bird than Rupa, Phewa lake and lower than Jagadishpur reservoir, Koshi barrage and Rapti and Narayani river systems. Hence, Beeshazari lake system can be considered as the biologically significant area with high conservation value.

Table 1. Wetland birds in Beeshazari lake system recorded during study period.

SN	Common Name	Zoological Name	Abundance	IUCN status	NRDB
Order: Accipitriformes, Family: Accipitridae					
1	Pallas's Fish Eagle	<i>Haliaeetus leucoryphus</i> Pallas, 1771	1	EN	CR
2	Grey-headed Fish Eagle	<i>Ichthyophaga ichthyaetus</i> Horsfield, 1821	3	NT	CR
Order: Anseriformes, Family: Anatidae					
3	Northern Pintail	<i>Anas acuta</i> Linnaeus, 1758	29	LC	EN
4	Common Teal	<i>Anas crecca</i> Linnaeus, 1758	34	LC	LC
5	Mallard	<i>Anas platyrhynchos</i> Linnaeus, 1758	9	LC	LC

6	Indian Spot-billed Duck	<i>Anas poecilorhyncha</i> Linnaeus, 1758	21	LC	NT
7	Gadwall	<i>Anas strepera</i> Forster, 1781	15	LC	LC
8	Lesser Whistling-duck	<i>Dendrocygna javanica</i> Horsfield, 1821	18	LC	LC
9	Little Pratincole	<i>Glareola lactea</i> Temminck, 1820	15	LC	NT
10	Pheasant-tailed Jacana	<i>Hydrophasianus chirurgus</i> Scopoli, 1786	20	LC	VU
11	Goosander	<i>Mergus merganser</i> Linnaeus, 1758	22	LC	LC
12	Bronze-winged Jacana	<i>Metopidius indicus</i> Latham, 1790	12	LC	LC
13	Cotton Pigmy-goose	<i>Nettapus coromandelianus</i> Gmelin, 1789	12	LC	VU
14	Red-wattled Lapwing	<i>Vanellus indicus</i> Boddaert, 1783	9	LC	LC
15	Yellow-wattled Lapwing	<i>Vanellus malarbaricus</i> Boddaert, 1783	24	LC	VU
Order: Ciconiiformes, Family: Ciconiidae					
16	Asian Openbill Stork	<i>Anastomus oscitans</i> Boddaert, 1783	58	LC	VU
17	Woolly-necked Stork	<i>Ciconia episcopus</i> Boddaert, 1783	3	VU	NT
18	Lesser Adjutant Stork	<i>Leptoptilos javanicus</i> Horsfield, 1821	26	VU	VU
Order: Coraciiformes, Family: Alcedinidae					
19	Common Kingfisher	<i>Alcedo atthis</i> Linnaeus, 1758	25	LC	LC
20	Blue-eared Kingfisher	<i>Alcedo meninting</i> Horsfield, 1821	22	LC	EN
21	Pied Kingfisher	<i>Ceryle rudis</i> Linnaeus, 1758	3	LC	LC
22	Black-capped Kingfisher	<i>Halcyon pileata</i> Boddaert, 1783	5	LC	LC
23	White-breasted Kingfisher	<i>Halcyon smyrnensis</i> Linnaeus, 1758	16	LC	LC
24	Stork-billed Kingfisher	<i>Pelargopsis capensis</i> Linnaeus, 1766	3	LC	LC
Order: Gruiformes, Family: Rallidae					
25	Brown Crake	<i>Zapornia akool</i> Sykes, 1832	16	LC	LC
26	White-breasted Waterhen	<i>Amaurornis phoenicurus</i> Pennant, 1769	60	LC	LC
27	Common Coot	<i>Fulica atra</i> Linnaeus, 1758	13	LC	LC
28	Purple Swaphen	<i>Porphyrio porphyrio</i> Linnaeus, 1758	33	LC	LC
29	Ruddy-breasted Crake	<i>Porzana fusca</i> Linnaeus, 1766	27	LC	LC
Order: Pelecaniformes, Family: Ardeidae					
30	Grey Heron	<i>Ardea cinerea</i> Linnaeus, 1758	7	LC	LC
31	Intermediate Egret	<i>Ardea intermedia</i> Wagler, 1829	18	LC	LC
32	Purple Heron	<i>Ardea purpurea</i> Linnaeus, 1766	6	LC	LC
33	Indian Pond Heron	<i>Ardeola grayii</i> Sykes, 1832	31	LC	LC
34	Green Backed Heron	<i>Butorides striatus</i> Linnaeus, 1758	63	LC	LC
35	Great White Egret	<i>Casmerodius albus</i> Linnaeus, 1758	16	LC	LC
36	Little Egret	<i>Egretta garzetta</i> Linnaeus, 1766	100	LC	LC
37	Cinnamon Bittern	<i>Ixobrychus cinnamomeus</i> Gmelin, 1789	6	LC	LC

38	Yellow Bittern	<i>Ixobrychus sinensis</i> Gmelin, 1789	8	LC	LC
39	Black-crowned Night Heron	<i>Nycticorax nycticorax</i> Linnaeus, 1758	30	LC	LC
Order: Pelecaniformes, Family: Threskiornithidae					
40	Black Ibis	<i>Pseudibis papillosa</i> Temminck, 1824	3	LC	LC
Order: Podicipediformes, Family: Podicipedidae					
41	Black-necked Grebe	<i>Podiceps nigricollis</i> Brehm, 1831	12	LC	LC
Order: Strigiformes, Family: Strigidae					
42	Brown Fish Owl	<i>Ketupa zeylonensis</i> Gmelin, 1788	8	LC	VU
Order: Suliformes, Family: Anhingidae					
43	Oriental Darter	<i>Anhinga melanogaster</i> Pennant, 1769	12	NT	NT
Family: Phalacrocoracidae					
44	Great Cormorant	<i>Phalacrocorax carbo</i> Linnaeus, 1758	39	LC	NT

(Here, NRDB= Nepal Red Data Book, CR= Critically endangered, EN= Endangered, VU= Vulnerable, NT= Near threatened, LC= Least concerned).

We found higher diversity of the wetland bird in winter (Shannon's index of diversity $H=3.423$, Simsom index $1-D=0.96$, Jacob's equitability $J=0.921$, evenness= 0.747) than summer ($H=2.91$, $1-D=0.92$, $J=0.893$, evenness= 0.706). Species dominance index was found higher in summer ($D=0.0723$) than in winter ($D=0.0399$) (Table 2). Diversity profile curve of wetland birds at

95% confidence interval showed significantly ($F=3.811$, $df=85.74$, $p=0.05$) higher diversity in winter as compared to summer (Figure 2). Similar type of study conducted in Phewa lake also found higher diversity of birds in winter ($H=2.6228$) than in summer ($H = 1.2014$) (Giri & Chalise, 2008).

Table 2: Wetland birds species diversity and dominance indices in BC.

Category	Total	Winter	Summer
Species richness	44	41	26
Abundance	913	563	350
Dominance_D	0.04188	0.03997	0.07236
Simpson_1-D	0.9581	0.96	0.9276
Shannon_H	3.442	3.423	2.91
Evenness_e^H/S	0.7105	0.7476	0.7062
Equitability_J	0.9097	0.9217	0.8932

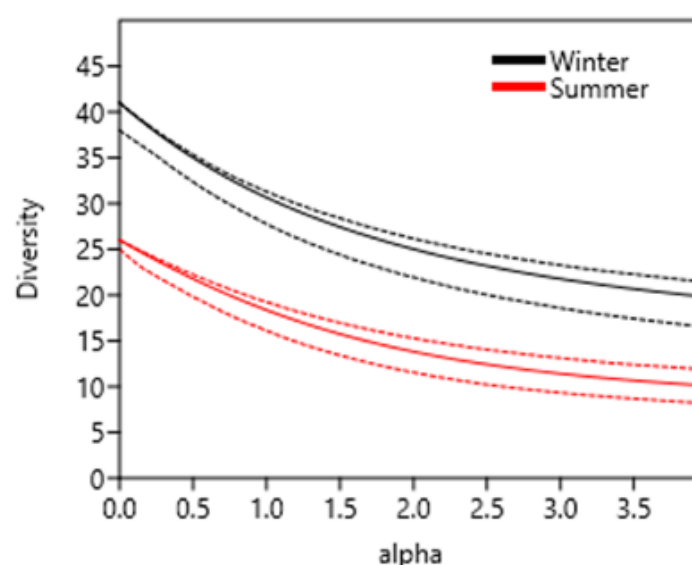


Figure 2: Species Diversity profiles of wetland birds in Beeshazari lake system at 95% confidence interval (dotted lines).

Conservation value of Beeshazari and associated lakes

Beeshazari lake system supports 8.10% of globally threatened birds (37 species) and 10.06% of nationally threatened wetland birds. This study recorded three globally vulnerable wetland birds (Pallas's Fish Eagle *Haliaeetus leucoryphus*, Lesser Adjutant Stork *Leptoptilos javanicus*, Woolly-necked Stork *Ciconia episcopus*) and two globally near threatened birds (Grey-headed Fish Eagle *Ichthyophaga ichthyaetus*, Oriental Darter *Anhinga melanogaster*) (BCN & DNPWC, 2011). Fifteen species of birds recorded from Beeshazari lake system are listed as threatened birds in National Red Data Book (NRDB). Among them, two are critically endangered (Pallas's Fish Eagle and Grey-headed Fish Eagle), two are endangered (Northern Pintail *Anas acuta*, Blue-eared Kingfisher *Alcedo meninting*, six are vulnerable (Pheasant-tailed jacana *Hydrophasianus chirurgus*, Cotton Pigmy-goose *Nettapus coromandelianus*, Yellow-wattled Lapwing *Vanellus malarbaricus*, Asian Openbill Stork *Anastomus oscitans*, Lesser Adjutant Stork *Leptoptilos javanicus*, Brown Fish Owl *Ketupa zeylonensis*) and five near threatened (Indian Spot-billed Duck *Anas poecilorhyncha*, Little Pratincole *Glareola lactea*, Woolly-necked Stork *Ciconia episcopus*, Oriental Darter *Anhinga melanogaster*, Great Cormorant *Phalacrocorax carbo*). (Grimmett et al., 2016) (Table 1). BCN and DNPWC (2011) described 149 nationally threatened birds including 61 Critically

Endangered, 38 Endangered and 50 Vulnerable species.

The major threats to wetland birds are fishing, livestock grazing and human disturbances in most of wetland areas of Chitwan. However, livestock grazing is not common as it is prohibited in and around Beeshazari lake areas. Besides, fishing practices (e.g. fishes, snails) are more common in associated lakes of Beeshazari lake and other small ponds. Tourists (both local and foreign) pressure was found the most common in Beeshazari lake area. Our results showed the negative relationship (Figure 3; $y = -0.427x + 4.723$, $R^2 = 0.058$, $F = 3.591$, $P = 0.0001$) between number of fisherman and abundance wetland birds. The number of tourists present in and around the Beeshazari lake system showed significantly negative impact on the abundance of wetland birds (Figure 4; $y = -0.261x + 5.382$, $R^2 = 0.127$, $F = 2.535$, $P = 0.002$). The study of wetland birds in Yangtze river found human disturbance, habitat loss, eutrophication and pollution are the major drivers of distribution and abundance of wetland (Jia et al., 2018). Many migratory wetland birds are threatened due to destruction and degradation of wetlands in Nepal and abroad (Lamsal et al., 2018; Prusty et al., 2017). Similar type of problem and impact of eutrophication and a huge colonization of invasive species were highly common in Beeshazari lake system (e.g., depleted Sorhahazar, Satrahazar, Athaishazar lakes).

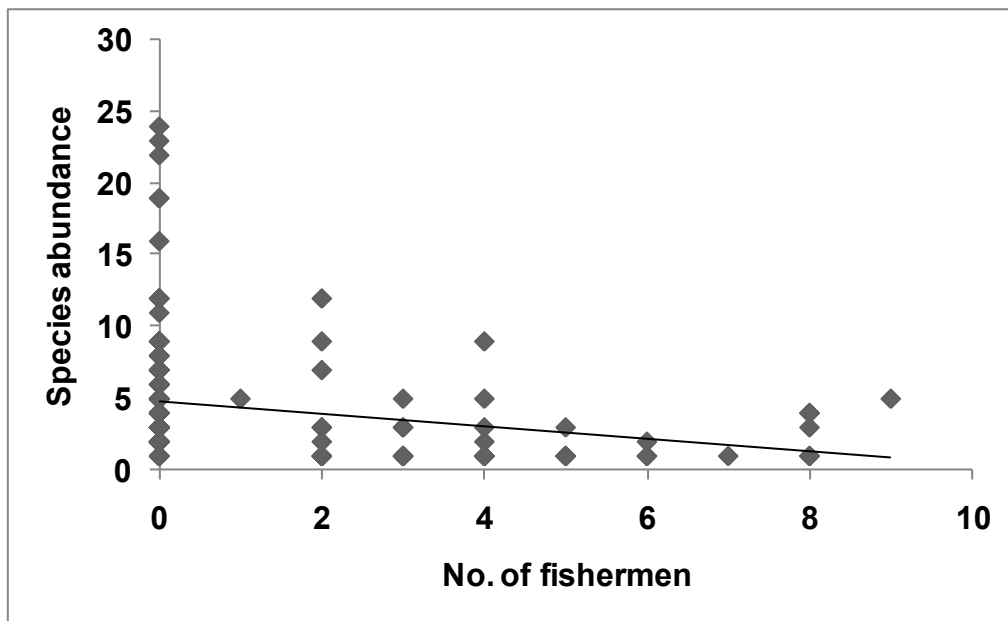


Figure 3: Effect of fishermen on the occurrence and abundance of wetland birds in Beeshazari lake system ($y = -0.427x + 4.723$, $R^2 = 0.058$, $F = 3.591$, $P = 0.0001$)

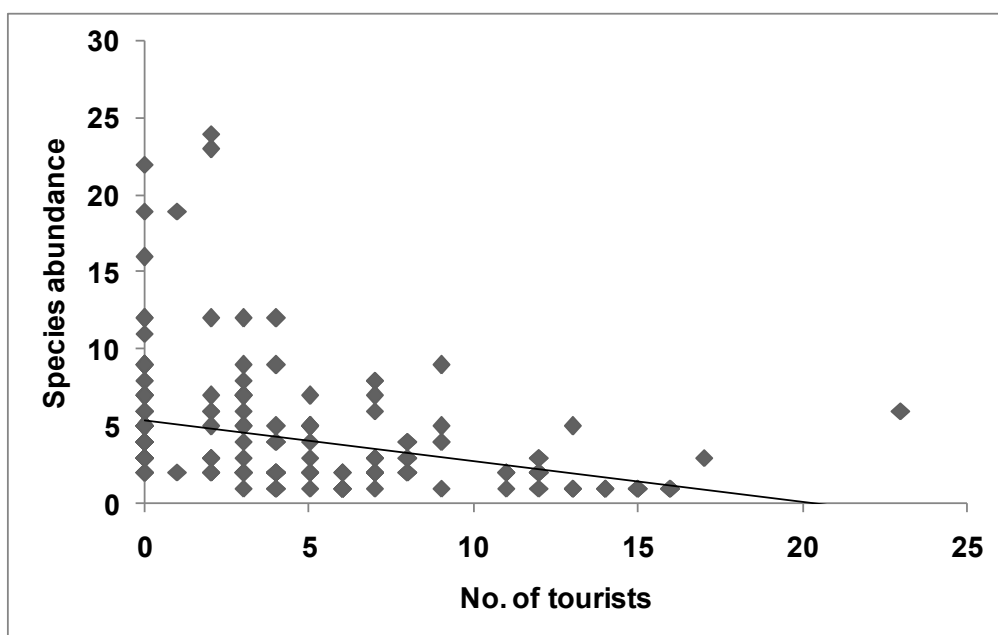


Figure 4: Effect of tourists pressure on the occurrence and abundance of wetland birds in Beeshazari lake system ($y = -0.261x + 5.382$, $R^2 = 0.127$, $F = 2.535$, $P = 0.002$).

Conclusion

Present study explored a total of 913 wetland birds belonging to 44 species, 11 families and 9 orders in Beeshazari lake system in 2017. This study shows that Anseriformes had highest number of species (13 species) than Pelecaniformes (11 species), Coraciiformes (6 species), Gruiformes (5 species), Ciconiiformes (3 species), Suliformes (2 species), Accipitriformes (2 species). Only one

species was recorded from Podicipediformes and Strigiformes. The species diversity of wetland birds was more in winter ($H=3.423$) than summer season ($H=2.91$). However, the species dominance was low in winter ($D=0.399$) than summer ($D=0.072$) indicate more diversity of wetland birds in winter ($1-D=0.96$, $J=0.921$) than summer season ($1-D=0.921$, $J=0.893$). Fishermen ($R^2 = 0.058$, $F = 3.591$, $P=0.0001$) and tourist pressure ($R^2 = 0.127$, $F = 2.535$, $P = 0.002$) caused the significant

negative impact on the occurrence of wetland birds in many parts of the study sites. Wetlands of Beeshazari lake system support a total of 13.5% of globally threatened and 10.06% of the nationally threatened birds. So, present study reported that eutrophication and introduction of invasive species are the major problem of the lake destruction. Hence, controlling of eutrophication and regular cleaning up of the lakes should be immediate step for protecting the Beeshazari lake system.

References

- BCN (2018) *National Wetland bird Survey 2018*. Bird Conservation Nepal and Wetland International.
- BCN & DNPWC (2011). *The State of Nepal's Birds 2010*. Kathmandu, Nepal: Bird Conservation of Nepal and Department of National Parks and Wildlife Conservation.
- Bhattarai, B. P. (2012) *Distribution and diversity of storks in the adjoining areas of Chitwan National Park, Nepal*, Himalayan Biodiversity in the Changing World. (pp. 97-114): Springer.
- Bhujju, U. R., Shakya, P. R., Basnet, T. B & Shrestha, S. (2007). *Nepal biodiversity resource book: protected areas, Ramsar sites, and World Heritage sites*. International Centre for Integrated Mountain Development (ICIMOD).
- Bibby, C. J. (2000) *Bird census techniques*. Elsevier.
- Chhetri, D.T. (2006) Diversity of Wetland Birds around the Koshi Barrage Area. *Our Nature* 4: 91-95.
- CNP (2018) *Biodiversity of Chitwan National Park*. <http://chitwannationalparkgovnp/index.php/biodiversity> (Accessed 17 February 2018).
- Dahal, B.R., McAlpine, C.A and Maron, M. (2015) Impacts of extractive forest uses on bird assemblages vary with landscape context in lowland Nepal. *Biol. Conserv.* 186: 167-175.
- DNPWC (2018) Department of National Parks and Wildlife Conservation, Nepal. Web: <http://dnpwcgovnp/>, Accessed on 19 February 2018.
- Gilani, H., Qamer, F.M. Sohail, M. Uddin, K. Jain, A. & Ning, W (2017) *Review of Ecosystem Monitoring in Nepal and Evolving Earth Observation Technologies Land Cover Change and Its Eco-environmental Responses in Nepal*. Springer. 165-183pp.
- Giri, B. & Chalise, M.K. (2008) Seasonal diversity and population status of waterbirds in Phewa lake, Pokhara, Nepal. *Journal of Wetlands Ecology* 1(1): 3-7.
- Green, A.J. & Elmberg, J. (2014) Ecosystem services provided by waterbirds. *Biol. Rev.* 89(1): 105-122.
- Grimmett, R., Inskipp, C., Inskipp, T. & Baral, H.S. (2016) *Birds of Nepal: Revised Edition*. Bloomsbury Publishing.
- Hammer, Ø., Harper, D. & Ryan, P. (2001). PAST-Palaeontological statistics. www.uv.es/~pardomv/pe/2001_1/past/pastprog/past.pdf, accessed em, 25(07): 2009.
- Inskipp, C., Baral, H.S., Inskipp, T., Khatiwada, A.P., Khatiwada, M.P., Poudyal, L.P. & Amin, R. (2017) Nepal's National Red List of Birds. *Journal of Threatened Taxa*. 9(1): 9700-9722.
- IUCN (2018) *The IUCN Red List of Threatened Species*. Version 2017-3 <www.iucnredlist.org> Downloaded on 24 February 2018.
- Jia, Q., Wang, X., Zhang, Y., Cao, L. & Fox, A.D. (2018) Drivers of waterbird communities and their declines on Yangtze River floodplain lakes. *Biol. Conserv.* 218: 240-246.
- Kafle, G., Cotton, M., Chaudhary, J.R., Pariyar, H., Adhikari, H., Bohora, S.B. & Regmi B. (2008) Status of and threats to waterbirds of Rupa Lake, Pokhara, Nepal. *Journal of Wetlands Ecology* 1(1): 9-12.
- Khadka, B.B., Acharya, P.M. & Rajbhandari, S.L. (2017) Population status and species diversity of wetland birds in the Rapti and

- Narayani rivers and associated wetlands of Chitwan National Park, Nepal. *Journal of Threatened Taxa* **9(6)**: 10297-10306.
- Lamsal, P., Kumar, L., Aryal, A. & Atreya, K. (2018) Invasive alien plant species dynamics in the Himalayan region under climate change. *Ambio* 1-14.
- NLCDC (2018) Ramsar sites of Nepal. National Lake Conservation and Development Committee. <http://nepallakegovnp/2017/05/01/ramsar-sites-of-nepal/> down loaded on: 24 February 2018.
- Parchizadeh, J. & Williams, S.T. (2018) Water birds targeted in Iran's wetlands. *Science* **359(6378)**: 877-878.
- Prusty, B.A., Chandra, K., R. & Azeez, P. (2017) *Wetland Science: Perspectives From South Asia*: Springer.
- Thapa, J.B. & Saund, T.B. (2012) Water Quality Parameters and Bird Diversity in Jagdishpur Reservoir, Nepal. *Nepal Journal of Science and Technology*. **13(1)**: 143-155.
- Thapa, T.B. (2011) *Habitat suitability evaluation for Leopard (Panthera pardus) using remote sensing and GIS in and around Chitwan National Park, Nepal*. Saurashtra University. (PhD Thesis)
- Zhu, D., Wu, N., Bhattarai, N., Oli, K.P., Tsering, K., Rawat, G.S. . . Joshi, S. (2015) A comparative study of daytime-based methane emission from two wetlands of Nepal Himalaya. *Atmos. Environ.* **106**: 196-203.

Managing Rivers for Sustainable Peace & Prosperity

Megh Ale

Ashoka Fellow

Founder / President

Nepal River Conservation Trust (NRCT)

Koshi Tragedy

The Koshi Chaos: 18th August 2008- It was not a natural disaster, but a man-made tragedy....

Over a hundred and ninety thousand people have been displaced in Nepal alone, more than 2.5 million people were made homeless and thousands were washed away and killed. Even today, thousands of them are still homeless in the lowlands of Eastern Nepal and in the State of Bihar in India. The Koshi flood situation (when the Koshi River broke the manmade barrier and took its original course) is among the worst manmade disaster in the history of modern world. This is just a beginning of what lies ahead in the future if we do not stop destroying the natural resources. We should all be prepared to face the consequences when Mother Nature loses her tolerance and unleashes her fury.

There is an alarming concern worldwide as to how we can save and manage some of these Himalayan rivers which flows all over from Amu Darya in Afghanistan, Pakistan, India, Nepal, Tibet (China), Bangladesh, Bhutan and Mekong River between Myanmar and Thailand. Many of these rivers are cross-bordering and have created ill feelings between some of the countries. Our primary concern is what can be done to conserve these rivers as they are degrading day-by-day.

Within the next 20 years, many of these rivers will be gone, many big dams will be built, and many glaciers will disappear resulting from the effects of climate change. As we all know, each and every Himalayan river are proposed to be dammed, it is only a matter of time and money. If we are not able to stop this and if this happens, there will be no free-flowing rivers for our future generations and the impact on the ecosystem will be huge as it will add more to the global warming and climate change. No matter what we do on the river, these important things have to be addressed and for this we need to be aware about our river communities, politicians and the policy makers.

Himalayan Rivers are the lifeline and the livelihood of close to 1.4 billion people. We cannot afford to take this risk and must do something about it. There will be many man-made disasters like Koshi if we do not look into this situation compassionately and carefully before more dams are built in the near future. This is the agenda I would like to put forward to all the concerned people and organizations. It seems like in Asia, especially in the Himalayan river basins, we have taken the rivers for granted. Whenever we talk about the river in this region, we, especially the politicians and the corporate houses, have an inclination to think in terms of megawatts and mega dollars that can be made and this comes first before anything else. We must change our

mindset about our rivers as there is more to it than just megawatts and money. We simply cannot give away our livelihood to a handful of rich people. Just imagine- if all the Himalayan rivers are dammed, what sort of impact will it have on the livelihood of the people, let alone the ecosystem? The impact on our ecosystem, the river communities, the aquatic life and the livelihood of the people, among other important considerations should be borne in mind. When and where will it stop are the questions that all of us should ponder very carefully while weighing all the pros and cons in a holistic manner instead of just seeing it as a piece-meal solution. We are not against the development of hydro dams but there has to be an ecological balance for the economic development and growth in Nepal. In this hitch modern world, there are many ways to generate power. Why should we not look for other alternative solutions and other renewable energy resources so as to come up with micro hydro and small hydropower?

What are the steps that we need to take next in order to save some of the Himalayan Rivers?

- Form an umbrella organization, which could be Himalayan Rivers Network (HRN). The organization's job would be to network with all the other river conservationists and communities from Afghanistan to Pakistan, Northern India, Nepal, Bangladesh, Tibet/China, Bhutan and Mekong river basins in Myanmar and Thailand.
- The network will share all the river information for effective management of the rivers, river conservation and other issues on Himalayan Rivers such as the melting of glaciers due to climate change and global warming.
- Most of the time when private companies or government bodies want to build a dam, there are no public or environmental groups to apply pressure through lobbying to stop them. HRN can be the body which will carry forward the voice of the Himalayan river communities. We all know that when we join hands, we will be much stronger.
- The network will organize seminars and

campaigns to stop the development of unhealthy dams in various regions. It will also work directly with the communities to educate and raise awareness amongst them.

- The network will address various issues faced by the Himalayan rivers. These issues cannot be taken for granted as these rivers are the lifeline of over 1.4 billion people in this region. We will pressurize the politicians, policymakers and the corporate sector to think seriously before they launch any destructive activities.
- The network will address the present situation including floods and other manmade disasters and raise awareness about the impact that the dams, when built, will have on global warming, climate change and our eco-system.
- We must lobby with the governments of the Himalayan Regions to leave at least one free flowing river in each country and should also promote managing and sustaining of micro-hydro schemes by utilizing the rivers instead of constructing bigger dams. The network will assist us in doing so.
- The network will assist in lobbying for UN Declaration of the International River Day celebration as we firmly believe that:
 - Rivers, such as Nile, Sindhu, Mesopotamia and Yangzi rivers among others, are the beginning of human civilization
 - River is precious and sacred in all religion
 - River is the artery of the Earth without which the Earth cannot sustain itself
 - River serves a mitigation function for our environment and is a true reflection of our biodiversity
 - River is our livelihood which cannot be fulfilled through other developments
 - River is the lifeline of all human beings

- The network will organize the Himalayan River Summit in different countries once in every two years so that knowledge and other updates regarding the Himalayan river basin countries can be exchanged. It will also be a platform to measure what have been accomplished in river conservation so far and what needs to be done in the future for effective implementation.
- The network will work towards carrying the voice of Himalayan rivers to the International River Summit and at the same time it will also address the nation's issues regarding our rivers.
- This model can be implemented in riparian regions and continents where the river is the source of livelihood for people.

International River Day

Celebrating the International River Day can be a good wake up call for all of us to realize the damages that we have done to our rivers and what we can do to revive it. What it means is: taking care of our drinking water, irrigation, biodiversity, livelihood of the people, addressing climate change and global warming issues as the rivers are drying up and the glaciers are melting, taking care of watersheds, stopping environment unfriendly dam constructions, managing our rivers wisely and reminding people again that the river is sacred in all religions and it serves as a hallmark of our civilization on the Earth.

While celebrating the International River Day, I hope that all of us understand the extent of our mistakes, the damages that we have already done to our precious rivers and come up with various ways to rectify our mistakes.

This is the right time to change our mindset, there are many cross-border rivers and we have always considered it as a dividing factor between the countries, between states, between the cities and villages. Not only that, there have been a lot of ill feelings between the countries and states about the rivers' ownership and sharing. Many experts predict the next big war will be over freshwater. We all have already experienced the change in climatic variability and effect of climate change. In addition, our freshwater storage is melting day by day. As responsible as we are, do we still want to wait till the last moment or do we want to act now to preserve the precious rivers for our future generations? Now is the time to look at the rivers as a uniting factor instead of a dividing one and think of ways so that this gift of Mother Nature can be shared wisely among all the stakeholders of this planet. The declaration of International River Day is a good beginning to address this issue. I urge the UN Head Quarter to take this matter very seriously and to support the declaration of the International River Day, every year on February 28.

Thank you very much for all your support to save our human civilization and our roots.

Contrasting Characteristics of Water Quality in the Kali and Seti Rivers

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Abstract

The Kali and Seti Rivers are the two major tributaries of the Gandaki River, upper Gange River Basin. We describe the chemical characteristics of contrasting tributaries of lee and windward sides of the central Himalaya, Nepal. Compared to the average data monitoring, these tributaries show a wide range of geochemical signatures, from highly diluted white color waters with low electrical conductivity (EC), and total dissolved solids (TDS) in the Seti River to highly elevated concentrations of dissolved ions with substantially high values of EC and TDS with black color water in the Kali River. On site and laboratory analysis of hydro-chemical variables showed wide variations in their values in both tributaries and confirm that different controlling mechanisms are acting during different hydrological stages in both

the sides of the Himalaya. The pH and HCO_3^- values were found higher in both the tributaries indicating the carbonate dominated lithology in the region. The TDS ranged between 34-1005 mgL^{-1} (mean values $418 \pm 197 \text{mgL}^{-1}$) in the Kali River whereas it is of 28-291 mgL^{-1} (mean values $133 \pm 74 \text{mgL}^{-1}$) in the Seti River i.e., more than threefold higher values primarily controlled by, and was strongly correlated to, the contrasting climatic and lithological characteristics. The low TDS observed in the Seti River underscores the characteristics of high dilution in the windward side of the Himalaya i.e., high precipitation. The measured hydro-chemical variables determining the quality of water for drinking and irrigation purposes reveal that both the basins have mostly retained the natural water quality with relatively more suitable water in the Seti River. The results of this study can provide important scientific reference for the comparisons and formulate the

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policies to manage the water resources in either side of the Himalaya.

Key Words: Hydrogeochemistry, Contrasting Segments, Kali River, Seti River, Water Quality

Background

The assessment and monitoring of quality has become a highly important field as global climate change, increasing developmental activities and population pressure have stressed finite freshwater resources (Carere, Miniero, & Cicero, 2011; Pant et al., 2018). It has been widely accepted that surface water quality is rapidly declining worldwide, particularly the issues are more serious in developing countries. The surface water quality is controlled by both the natural processes, i.e. precipitation inputs, land topography, geochemical weathering, and the anthropogenic activities via various point and non-point sources (Thomas, Joseph, & Thrivikramji, 2015). The literature revealed that the surface water quality has deteriorated noticeably in many river basins due to various natural and anthropogenic activities in the past few decade (Paudyal, Kang, Sharma, Tripathee, & Sillanpää, 2016). Besides some major anthropogenic activities such as agriculture, urban settlement, industrial accomplishments, there is a strong relationship between changing water quality and climatic and topographical heterogeneity (Thomas, Joseph, Thrivikramji, Manjusree, & Arunkumar, 2014) MRB (a major tributary of Periyar, the longest river in Kerala, India. Therefore, researchers have also been paying attentions to the effect of natural variations on water quality, in particular the key contributors of climatic and topographic factors.

The river basins in high Himalaya located in the lee and windward sides show distinct characteristic features, and can greatly influence the water quality of either side (Pant *et al.*, 2018; Trower, 2009). Past findings highlight the importance of the water quality in the high Himalaya, for instance, Thomas *et al.* (2015) reports that semi-arid segment of the river has substantially high concentrations of TDS as compared to humid to sub-tropical region. The extent and the scale of the influences on water hydrochemistry due to presence of high mountain barriers are yet to be discussed in detail (Paudyal, Kang, Sharma,

Tripathee, Huang, *et al.*, 2016). In Nepal, almost all major rivers have been tapped as a source of drinking water supplies; but there is no regular monitoring and assessment of water quantity or quality. The demand for water is rapidly increasing for domestic needs, agriculture, industry and other sectors (Tripathee, Kang, Sharma, *et al.*, 2016).

The Kali River is the head water region of the Gandaki River basin originated from the adjoining areas of the Tibetan Plateau whereas the Seti River is originated from the windward side of the Himalaya (Pant et al., 2018; Panthi et al., 2015). Both of the sub-basins are the important sources for Nepal for domestic, industrial and irrigation usages in the region (Bajracharya, Acharya, & Ale, 2011). Studies have reported increased concentrations of major ions in the headwater regions of the Kali Gandaki River. In case of the Kali River, the global climate change and its impacts on the headwater region of the Tibetan Plateau, land use changes and other natural geochemical processes are the primary factors influencing water quality. Thus, the local lithogenic formation, semi-arid region and climatic factors have been increasingly becoming the key contributors to the declining water quality in the river (Pant et al., 2018). On the other hand, in the Seti River the run-off from agricultural fields laden with chemical fertilizers, pesticides and herbicides, discharge of untreated sewage from the settlements, especially urban areas along the river banks are the major sources of river water pollution (Shrestha, Pradhan, Tachamo, & Shah, 2009). Previous literatures focus only on the certain segment of the river basin and very limited comparative assessment researches are available from the lee and wind ward side of the high Himalaya. Thus, this study demonstrated the comparative assessment of water quality variability of physico-chemicals of the riparian areas in order to develop sustainable water conservation strategies in the basin.

Material and Methods

Study Area: Kali River

The Kali River is a highly important feature in the central Himalaya Nepal. Its source is located near the Tibetan border that

coincides with the Tibetan border and Ganga-Brahmaputra watershed divide. The Kali River (leeward side) is the main tributary of the Gandaki River Basin, a head water tributary of Ganges. It flows through a sheer-sided, deep canyon immediately south of the Mustang capital of Lo Manthang, then widens as it approaches Kagbeni. The river continues southward past Jomsom, Marpha, and Tukucho to the deepest part of the gorge about 7 km south of Tukucho in the area of Lete. This study primarily focuses on the Kali River region between Tibetan Plateau and Himalayan Mountain called Trans-Himalaya. The basin drains the region of north arid to semi-arid climate, with a mean annual temperature of 9°C. The hydrology and water availability of the basin demonstrates a strong seasonal variability. The basin has a mean annual precipitation of approximately 163 mm. The Kali River basin consists predominantly of Paleozoic and Mesozoic sedimentary rocks (limestones, shales and sandstones) with abundant fossils (cretaceous) and evaporites (halite, polyhalite, anhydrite, and gypsum). The major vegetation is bushes and grasses. The farmlands are located along the river side but very scattered and subsistence in nature. The major crops are barley, wheat, millet and buckwheat. Many people in Kali River basin depend on animal husbandry i.e., sheep and mountain goat rearing for their livelihood.

Study Area: Seti River

The Seti River is another highly important feature of the windward side of the central Himalaya Nepal. The Seti River Basin is located in the Lesser

Himalayas Region. The river originates from the Annapurna Himalayas (elevation > 8000 m) and flows through the central region of Pokhara Valley. Its watershed area is approximately 3000 km² and the main river traverse of about 150 km before joining in the Trisuli River. The major tributaries of the river are: Sardi, Mardi, Yamgdi, Kali, Bijayapur, Kotre and Madi. The sub-basin enjoys a sub-tropical monsoon climate with a mean annual temperature of 19°C. The hydrology and water availability demonstrates a strong seasonal variability. The basin is also known as the highest rainfall area in Nepal with a mean annual precipitation approximately of 3710 mm and more than 80% annual precipitation is concentrated during the monsoon season i.e. June to September (Khadka and Ramanathan, 2013). As a general pattern, river discharge increases downstream due to the inputs from tributaries and heavy rainfall. Pokhara is formed of quaternary deposits. The quaternary deposits consist of mostly calcareous rocks which are karstified in the form of sinkholes, and pinnacles (Gautam, Pant, & Ando, 2000). The major vegetation are trees, bushes and grasses. The farmlands are located along the river side but in a very scattered form mostly depending on the subsistence farming (Rimal, Baral, Stork, Paudyal, & Rijal, 2015). The major crops are rice, wheat and maize. Since, the highly populated Pokhara-Lekhnath metropolitan city is located in this basin, it attracts a large population from the surrounding areas. It accounts for one of the highest growth rate of population among the designated towns in the country. Diversified livelihood services (such as agriculture, government services, business, industrial works)

are available in the region (Thapa & Weber, 1995).

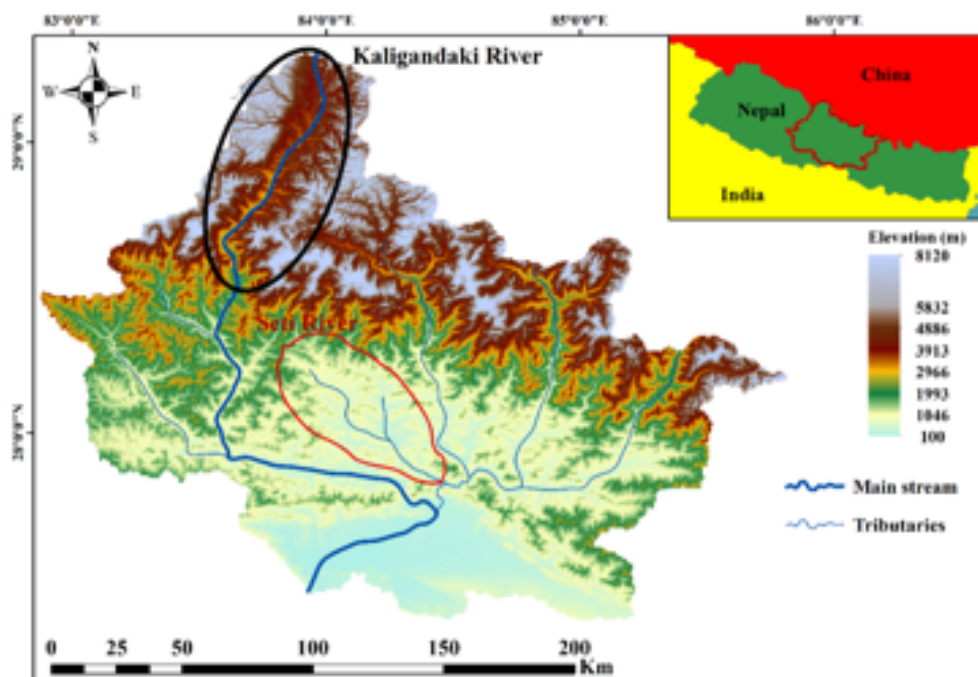


Figure 1: Study Area Locating the Kali and Seti Rivers in Gandaki River Basin, Nepal

Sampling and Analysis

A total of 60 samples were collected from the Kali River during monitoring seasons namely pre-monsoon, monsoon and post monsoon. From each season 20 samples were collected. Similarly, 45 water samples were collected from the Seti River during all the three monitoring periods (15 sample in each season). The study includes the comparative assessment of water quality parameters especially pH, EC, TDS and major ions, and the mean values of all those samples were used for the assessment. The primary objective of this study is to assess and compare the water quality of two sub-basins located in either side of the Himalaya. Thus, the study was based on the previous study conducted in the Gandaki River Basin, and the sampling locations, onsite measurements, laboratory analysis and quality control were explained in the published and unpublished dataset (Pant *et al.*, 2018).

Result and Discussion

Comparative Assessment of Hydrochemical Variables

In a high Himalaya, the chemical signature, and factors controlling the hydrochemistry have

obvious spatial discrimination (Mir, Jeelani, & Dar, 2016). Taking lithology into consideration, the leeward side is dominated by eolian deposits and lacustrine sediments while the windward side is by carbonate outcrops. Moreover, while considering the climate of the basin, it displays a bipolarity i.e., the intense radiation, strong evaporation, and low precipitation in the leeward side, and the high rainfall followed by discharge in the windward side of the Himalaya. Thus, the hydrochemistry in the windward side of the Himalaya is mainly controlled by the weathering of carbonates whereas in the leeward, it is synergistically influenced by weathering of carbonates and evaporites under the influence of distinctly different rainfall in both sides (Pant *et al.*, 2018).

The TDS and major ions displayed clear spatial discriminations, with lower concentrations in the windward and higher in the leeward sides. The distinct lithology and rainfall-discharge seasonality could explain this. The semi-arid segment of the basin has a significant role in elevated dissolved loads and, thus the Kali River supplies higher dissolved constituents with highly mineralized river water. The distinct patterns of chemical compositions of the Kali and Seti Rivers are illustrated in Figure 2. The results imply that the concentration of most of the hydro-chemical

attributes in the Kali samples is significantly higher, compared to the Seti samples, which is true for all sampling seasons. The water quality of such diverse environment is also reported from other areas having similar topographical conditions (Thomas *et al.*, 2015).

The Kali sub-basin is mainly affected by evaporation and crystallization processes, while the Seti sub-basin displayed the effects of carbonate weathering rocks. Thus, the Kali River has evaporite-related characteristics with the signature of Na-Cl type of water (some

samples). However, the Seti River has mainly a Ca-HCO₃ formation complex. The mean TDS in the Kali River was 417.82mgL⁻¹, which is 3.14 times higher than the mean values of the Seti River. Although the mean TDS was < 500 mgL⁻¹, in many sampling points in both the sub-basins. The maximum values of TDS exceeded 1000 mgL⁻¹, indicating the signature of evaporates in a few sampling locations. On the other hand, the TDS is lower in the Seti River, i.e., maximum 291 mgL⁻¹ and mean 133 mgL⁻¹, which is mainly due to highly diluted water under the influence of climatic seasonality (mainly monsoon-driven),

and there is a negligible contribution of the evapo-crystallization.

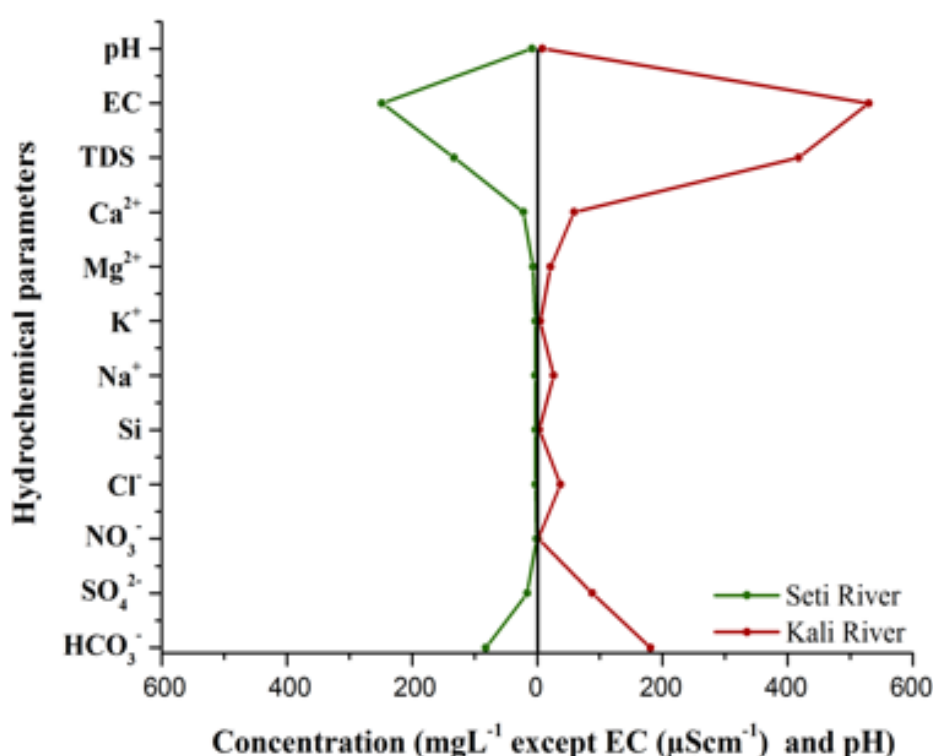


Figure 2: Hydro-chemical Attributes between Leeward (Kali) and Windward (Seti) Sides of the Gandaki River Basins

Like the TDS, the EC follows the same trend, and the mean EC and TDS concentrations in the Kali River were 3.31 and 3.14 times higher than the Seti River. Similarly, Ca²⁺, Mg²⁺, and K⁺ were 2.67, 3.20 and 1.71 times higher, respectively in the Kali River than that of the Seti River. Among the measured cations, a markedly high difference was observed for Na⁺ concentrations. The mean Na⁺ concentrations were 8.66 times higher in the Kali than that of the Seti River. The

silicate-weathering contributes very little to the dissolved ions in both the river basins, yet the mean concentration was 1.15 times higher in the Kali River than that of the Seti River. The mean concentrations of all major anions were higher in the Kali River (i.e., 13.24, 1.61, 5.54 and 2.20 for Cl⁻, NO₃⁻, SO₄²⁻ and HCO₃⁻, respectively). The dramatically higher concentration for Cl⁻ i.e., more than 13 times in the Kali River, was mainly likely a result of the local lithogenic processes. Also, the groundwater with thermal activities brings leached salts to the surface, resulting in salt accumulation. Nevertheless, in the Seti River, the thermal springs were reported relatively in

a few locations as compared to the Kali River. The water samples from these rivers mainly composed of bicarbonate due to the widespread distribution of carbonate rocks in the basin. The mean concentrations of the pH and Si were comparable to each other in both rivers, however, other parameters have significantly higher values in the Kali River.

The results and conclusions were consistent with other rivers having comparable lithology and climate around the globe (Huang, Sillanpää, Gjessing, Peräniemi, & Vogt, 2011; Kannel, Lee, Kanel, Khan, & Lee, 2007). Specifically, the hydrochemistry in the Seti River was comparable with the global mean values, which was relatively high in the case of Kali River. This is because the Seti River originated from the meltwater region and drained from the carbonate-dominated lithology, but the Kali River is originated from the adjoining areas of the Tibetan Plateau and drained from the semi-arid environment of the leeward side of the Himalaya. Notably, high Na^+ , Cl^- , and SO_4^{2-} concentrations in the Kali River were due to the domination of evaporates in the semi-arid segments (Jiang, Yao, Liu, Wang, & Wu, 2015).

In summary, it can be said that the climate of the Kali river (leeward side) and Seti river (windward side) of the river basin displays a bipolarity (i.e., dry and semi-arid in lee-ward side vs. humid sub-tropical in lee-ward side). A notable difference in the hydrochemistry of the two sub-basin in the region is mainly due to the supply of the highly mineralized waters in the semi-arid segments of the Kali river basin. Thus, the main hypothesis of this case study that the significant differences exist in the processes controlling hydrochemistry between the lee-and wind-ward sides of the high Himalaya within the basin has been confirmed.

Comparative Assessment of Water Quality

The river water is widely used for drinking and other domestic purposes in both of the sub-basins. Therefore, the water quality is one of the important parameters directly affecting both the human and ecosystem health. Apart from this, the agriculture is one of the major income sources in Nepal, and it directly depends upon rain-fed and irrigational water (Dahal *et al.*, 2016). Thus,

the suitability of water for drinking and irrigation purposes has great concern for human and crop health perspective (Thomas *et al.*, 2014)MRB (a major tributary of Periyar, the longest river in Kerala, India. The present study shows that the river water quality is mostly within the safe limits of the WHO guideline for drinking water quality in terms of ionic concentrations except for a few samples in the Kali River. For instance, the maximum concentrations of EC, TDS, Ca^{2+} , Mg^{2+} , and SO_4^{2-} exceeded the maximum permissible limits. All of the samples with above parameters exceeding or closer to the WHO guideline values were from the core semi-arid segment of the Kali sub-basin. The maximum values of pH in both sub-basins exceeded the recommended value, this is primarily due to the carbonate dominated lithology in areas. While comparing the water quality of both the sub-basin to the global mean, most of the hydrochemical attributes of the Seti River are comparable while most of the chemical attributes from the Kali River exceeded their concentration.

The suitability of water for irrigation depends upon type and concentrations of dissolved salts where Na^+ plays a vital role (Elango, 2005). Generally, high sodium contents in irrigation water cause the displacement of Ca^{2+} and Mg^{2+} by Na^+ . The displacement of Ca^{2+} and Mg^{2+} in soil reduces its permeability which affects crop yield causing calcium deficiency, and impairment of the tilth. Thus, the suitability of river water for irrigation can be assessed by estimating Na^+ % and Sodium Absorption Ratio (SAR). The irrigation water can be classified into five categories based on Na^+ % values (excellent < 20, good: 20-40, permissible: 40-60, doubtful: 60-80 and unsuitable > 80) (Richards, 1954; Wilcox, 1948). The calculated values of Na^+ % and SAR in the Kali and Seti rivers and compared with standard value. The mean value of Na^+ % in the Kali river was 19.42 ± 10.70 , indicating the excellent quality of water for irrigation purposes but very close to the second category i.e., good quality of water. The Na^+ % values were significantly lower in the Seti River water when compared to the Kali River indicating that the latter's water is less relatively suitable for the irrigation purpose.

Based on the SAR values, irrigation water is

classified into four groups (low < 10, medium: 10-18, high: 18-26 and very high: > 26) (Saleh & Shehata, 1999; Thomas *et al.*, 2014)MRB (a major tributary of Periyar, the longest river in Kerala, India with high SAR values indicating increased danger to the crops. In this study, the SAR values for both sub-basins were less than 2 which also exhibited good agreement with $\text{Na}^+\%$. Thus, from the irrigation suitability perspective, the overall water quality of both the Kali and Seti sub-basins were under the safe category with relatively better water quality in the Seti River.

Emerging Issues Related to Water Quality

This study is intended to pre-set scenario of the status of hydrochemical variables in both sides of Himalaya in Gandaki River Basin, Nepal. Understanding the characteristics of water quality and its controlling mechanisms is crucial for sustainable water management. This article attempts to highlight some of the complexities and challenges associated with the lee-ward side of the Himalaya. In addition, COP21 Paris report and other published documents highlighted that the Tibetan Plateau is warming nearly three times as fast as the rest of the Earth, which is one of the critical issues for the rivers originating from the highland areas of this region (Kang *et al.*, 2010). As the Gandaki River is also originated from the Tibetan Plateau the issues associated with global climate change and its consequences in the headwater regions of Tibetan Plateau definitely affect the water quality in the downstream regions. Thus, preparation of water quality database and analysis should be undertaken to characterize the water quality problems and identify the issues and measures relating to the sustainability of the Himalayan river basins. In addition, the issues associated with the anthropogenic activities such as pollution of potentially toxic trace elements, long range transport of the pollutants, rapid urbanization, industrialization, disposal of the waste to the surface water sources and religious activities especially in the confluence region of major tributaries are the matter of serious concern for the sustainability of the river basins in the Himalaya (Pant *et al.*, 2018; Paudyal, Kang, Sharma, Tripathee, & Sillanpää, 2016; Tripathee *et al.*, 2014; Tripathee, Kang, Sharma, *et al.*, 2016; Tripathee, Kang, & Sharma, 2016).

Conclusion

In summary, the climate of the Kali river (leeward side) and the Seti river (windward side) of the Gandaki River Basin displays a bipolarity (i.e., dry and semi-arid in lee-ward side vs. humid sub-tropical in lee-ward side). A notable difference in the hydrochemistry of the two sub-basins is mainly due to the supply of the highly mineralized waters in the semi-arid segments of the Kali River basin. Thus, the main hypothesis of this case study that significant differences exist in the processes controlling hydrochemistry between the lee-and wind-ward sides of the high Himalaya within the river basin has been confirmed. In Kali River, the water is more mineralized with dominance of Ca^{2+} , Mg^{2+} , Na^+ , Cl^- and SO_4^{2-} and can be explained by the semi-arid to arid climate as well as lithological differences. This is primarily because of the contrasting hydro-chemistry between the Kali and Seti Rivers i.e. waters in the Seti River are more diluted compared to the Kali River. The trends of TDS of the Kali and Seti rivers are markedly different. This study concludes that the natural factors affecting water quality such as climatic, geogenic and anthropogenic issues such as land use changes, disposal of waste waters, agricultural and industrial wastes must be recognized and addressed as soon as possible in either contrasting sides of the high Himalaya to make optimum use and sustainable management of freshwater resources in the Himalaya. In addition, this also provides scientific reference for the preliminary hydro-geochemical status of either side of high Himalayan river basin which could assist to formulate water resource-related policies for coordinating water resource utilization.

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References

- Bajracharya, T. R., Acharya, S., & Ale, B. B. (2011). Changing Climatic Parameters and its Possible Impacts in Hydropower Generation in Nepal (A Case Study on Gandaki River Basin). *Journal of the Institute of Engineering*, 8(1–2), 160–173. <https://doi.org/10.3126/jie.v8i1-2.5108>
- Carere, M., Miniero, R., & Cicero, M. R. (2011). Potential effects of climate change on the chemical quality of aquatic biota. *TrAC Trends in Analytical Chemistry*, 30(8), 1214–1221.
- Dahal, P., Shrestha, N. S., Shrestha, M. L., Krakauer, N. Y., Panthi, J., Pradhanang, S. M., ... Lakhankar, T. (2016). Drought risk assessment in central Nepal : temporal and spatial analysis. *Natural Hazards*, 80(3), 1913–1932. <https://doi.org/10.1007/s11069-015-2055-5>
- Elango, L. (2005). Groundwater quality and its suitability for drinking and agricultural use in Chithar River Basin , Tamil Nadu , India, 1099–1110. <https://doi.org/10.1007/s00254-005-1243-0>
- Gautam, P., Pant, S. R., & Ando, H. (2000). Mapping of subsurface karst structure with gamma ray and electrical resistivity profiles: a case study from Pokhara valley, central Nepal. *Journal of Applied Geophysics*, 45(2), 97–110.
- Huang, X., Sillanpää, M., Gjessing, E. T., Peräniemi, S., & Vogt, R. D. (2011). Water quality in the southern Tibetan Plateau: chemical evaluation of the Yarlung Tsangpo (Brahmaputra). *River Research and Applications*, 27(1), 113–121.
- Jiang, L., Yao, Z., Liu, Z., Wang, R., & Wu, S. (2015). Hydrochemistry and its controlling factors of rivers in the source region of the Yangtze River on the Tibetan Plateau. *Journal of Geochemical Exploration*, 155, 76–83.
- Kang, S., Xu, Y., You, Q., Flügel, W.-A., Pepin, N., & Yao, T. (2010). Review of climate and cryospheric change in the Tibetan Plateau. *Environmental Research Letters*, 5(1), 015101. <https://doi.org/10.1088/1748-9326/5/1/015101>
- Kannel, P. R., Lee, S., Kanel, S. R., Khan, S. P., & Lee, Y.-S. (2007). Spatial-temporal variation and comparative assessment of water qualities of urban river system: a case study of the river Bagmati (Nepal). *Environmental Monitoring and Assessment*, 129(1–3), 433–459.
- Mir, R. A., Jeelani, G., & Dar, F. A. (2016). Spatio-temporal patterns and factors controlling the hydrogeochemistry of the river Jhelum basin, Kashmir Himalaya. *Environmental Monitoring and Assessment*, 188(7), 24. <https://doi.org/10.1007/s10661-016-5429-6>
- Pant, R. R., Zhang, F., Rehman, F. U., Wang, G., Ye, M., Zeng, C., & Tang, H. (2018). Spatiotemporal variations of hydrogeochemistry and its controlling factors in the Gandaki River Basin, Central Himalaya Nepal. *Science of The Total Environment*, 622, 770–782.
- Panthi, J., Dahal, P., Shrestha, M. L., Aryal, S., Krakauer, N. Y., Pradhanang, S. M., ... Karki, R. (2015). Spatial and temporal variability of rainfall in the Gandaki River Basin of Nepal Himalaya. *Climate*, 3(1), 210–226.
- Paudyal, R., Kang, S., Sharma, C. M., Tripathi, L., Huang, J., Rupakheti, D., & Sillanpää, M. (2016). Major ions and trace elements of two selected rivers near Everest region, southern Himalayas, Nepal. *Environmental Earth Sciences*, 75(1), 1–11.
- Paudyal, R., Kang, S., Sharma, C. M., Tripathi, L., & Sillanpää, M. (2016). Variations of the Physicochemical Parameters and Metal Levels and Their Risk Assessment in Urbanized Bagmati River , Kathmandu , Nepal, 2016. <https://doi.org/10.1155/2016/6025905>

- Richards, L. A. (1954). *Diagnosis and improvement of saline and alkali soils*. (Vol. 78). LWW.
- Rimal, B., Baral, H., Stork, N., Paudyal, K., & Rijal, S. (2015). Growing City and Rapid Land Use Transition: Assessing Multiple Hazards and Risks in the Pokhara Valley, Nepal. *Land*, 4(4), 957–978. <https://doi.org/10.3390/land4040957>
- Saleh, A., & Shehata, M. (1999). Hydrogeochemical processes operating within the main aquifers of Kuwait, 195–209.
- Shrestha, M., Pradhan, B., Tachamo, R. D., & Shah, D. N. (2009). Water Quality Assessment and Associated Stressing Factors of the Seti River Basin, Pokhara Sub Metropolitan City, (August), 49–57. <https://doi.org/10.3126/jhm.v6i1.5488>
- Thapa, G. B., & Weber, K. E. (1995). Status and management of watersheds in the Upper Pokhara Valley, Nepal. *Environmental Management*, 19(4), 497–513. <https://doi.org/10.1007/BF02471963>
- Thomas, J., Joseph, S., & Thrivikramji, K. P. (2015). Hydrochemical variations of a tropical mountain river system in a rain shadow region of the southern Western Ghats, Kerala, India. *Applied Geochemistry*, 63, 456–471.
- Thomas, J., Joseph, S., Thrivikramji, K. P., Manjusree, T. M., & Arunkumar, K. S. (2014). Seasonal variation in major ion chemistry of a tropical mountain river, the southern Western Ghats, Kerala, India. *Environmental Earth Sciences*, 71(5), 2333–2351. <https://doi.org/10.1007/s12665-013-2634-2>
- Tripathee, L., Kang, S., Huang, J., Sharma, C. M., Sillanpää, M., Guo, J., & Paudyal, R. (2014). Concentrations of trace elements in wet deposition over the central Himalayas, Nepal. *Atmospheric Environment*, 95, 231–238.
- Tripathee, L., Kang, S., & Sharma, C. M. (2016). Preliminary Health Risk Assessment of Potentially Toxic Metals in Surface Water of the Himalayan Rivers, Nepal, 97(6), 855–862. <https://doi.org/10.1007/s00128-016-1945-x>
- Tripathee, L., Kang, S., Sharma, C. M., Rupakheti, D., Paudyal, R., Huang, J., & Sillanpää, M. (2016). Preliminary Health Risk Assessment of Potentially Toxic Metals in Surface Water of the Himalayan Rivers, Nepal. *Bulletin of Environmental Contamination and Toxicology*, 97(6), 855–862. <https://doi.org/10.1007/s00128-016-1945-x>
- Trower, L. (2009). Spatial variations in chemical weathering and CO₂ consumption in Nepalese High Himalayan catchments during the monsoon season. *Geochimica et Cosmochimica Acta*. Elsevier Ltd. <https://doi.org/10.1016/j.gca.2009.06.036>
- Wilcox, L. V. (1948). *The quality of water for irrigation use*. United States Department of Agriculture, Economic Research Service.

Closing Session

In the closing Session, Executive Director, Mr. Lanka Bahadur Shahi, on behalf of the Drafting Committee read the Pokhara Declaration which was approved by the participants with a big applause. Then a few dignitaries made some remarks, which are summarized as follows.

1. In closing remarks, the Chief Guest, Honorable Prithvi Subba Gurung, congratulated all the dignitaries and participants for making the Conference a great success. He mentioned that lakes and wetlands are one of the important components of the ecosystem. Therefore, they need to be conserved and used wisely, at least for us and for the future generation. He praised the NLCDC for organizing this conference and he expressed his hope that the deliberations made here will be implemented on the ground and thereby improves the overall status of lakes and lake resources in the region of South-east Asia. Details of his speech appears as second *Mantabya* (Remarks). The Chief Minister also gave away the certificates of participation to the participants, letter of appreciation to the Organizing Committee and souvenirs as a token of love to the international participants.
2. Honorable Bikash Lamsal, acknowledged the importance and values of the ecological services provided by lakes and wetlands. He appreciated the right decision taken by the NLCDC in organizing the Conference, despite different constraints including financial ones. He expressed his confidence that the deliberation of the Conference would prove to be a valuable guidelines and tools for the conservation and development of lakes and wetlands in Nepal in general and Gandaki Zone in particular. His extempore speech appears as third *Mantabya* (Remarks).
3. Mr. Bharat Pahari mentioned the importance of conference in generating new knowledge and information. He also highlighted the need for conserving lakes and wetlands sustainably. They are part and parcel of the ecosystem. Their conservation is, therefore, the key for the prosperity and sustainable development of Nepal.
4. Mr. Bain Bahadur Chettri Adhikari, Chief of the Kaski District Coordination Committee said that the development of tourism, agriculture and infrastructure is closely linked with the livelihood of people and therefore their development is, no doubt, the pre-requisite for the prosperity of Nepal. Lake resources are also no less important than other resources. So our goal should always be the wise use of lakes and lake resources.
5. Mr. Bishwo Prakash Lamichhane, the former Chief of the Pokhara Nagar Committee linked the lakes with the development of human civilization. Without lakes, civilization would not have come this way. Therefore, there is a great need for the conservation of lakes and wetlands for us and for the future generation.
6. Prof. Dr. Masahisa Nakamura applauded endorsement of the Pokhara Declaration by the floor and the formation of the Ad Hoc Committee of the ILBM Platform in South Asia is a forward looking step for the effective management and conservation of lakes and lake resources at the basin level. The ILEC would support the NLCDC for

the promotion of the Declaration in the region.

Then, the Chairperson of the Session, Mr. Nani Kaji Thapa, Chairman of the NLCDC offered his vote of thanks to the Chief Guest, dignitaries, participants, authors, the media and supporters for their kind support to and facilitating the organization of the Conference.

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