CASE STUDY: WIND IMPACT ON SHORELINE CHANGE IN FRONT OF A RIVER MOUTH IN LAKES

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1. INTRODUCTION

Up to the present different study approaches have been carried out on shoreline change in a lake; for instance, in Lake Biwa (Tsuchiya et al. 1984) and in Lake Kasumigaura (Uda et al. 1998) giving new insights into understanding basic process of sand movement and erosion in lakes. Fujita & Tanaka (2002) used topographical maps and aerial photographs around the mouth of Nagase River for analyzing the wind-impact on sediment transport and erosion.

The present study: "CASE STUDY: WIND IMPACT ON SHORELINE CHANGE IN FRONT OF A RIVER MOUTH IN LAKES" makes a comparison between shoreline change in front of Tuni River Mouth and Nameless River Mouth with Shoreline Change around the Mouth of Nagase River in Lake Inawashiro (Fujita & Tanaka 2002), analyzing wind impact as erosive factor.

Trying to understand the erosive phenomena will be helpful for future studies on sediment transport and deposition model.

2. STUDY AREA AND DATA COLLECTION

The study area, Lake Tuni (located in La Paz, Bolivia) provides important water resources to two major cities of Bolivia (La Paz and El Alto). Furthermore Global Climate change will accelerate glacier retreat and it may result in accelerate sediment deposit reducing the capacity of the lake.

In Lake Tuni were found two sandspits placed in front of two rivers, one of them is called Tuni River and the other one was called Nameless.

Tuni River originates in Tuni Glacier, it flows for 5.46 Km be-fore draining into Lake Tuni, and it has a river basin area of 9.98 Km2. On the other hand, Nameless River flows for 0.94 Km before draining into Lake Tuni, and it has a river basin area of 0.65 Km2. Fig. 1 is an outline of Lake Tuni, and shows the target area around the mouth of Tuni River and Nameless River.

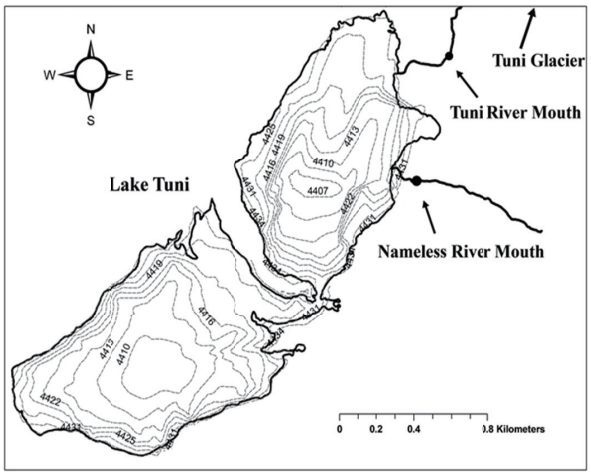

Fig1: Study Area

For the analysis of shoreline change, data of wind direction and speed (from June 2011 to May 2012), bathymetric measurements performed in 2000 and water level data (from 2000 to 2012) of the lake were provided by EPSAS (Social Public Enterprise of Water and Sanitation in La Paz).

Despite the lack of topographical data, Geo-Eye satellite images were used for the periods: November 2005, August 2009, May 2011 and September 2012.

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3. DATA ANALYSIS

In Bolivia the raining season extends from January to March, while dry season extends from June to August. Water elevation in Lake Tuni through a year is depicted in Fig 2-3. Due to fluctuations in the water level sandspit are well recognizable only during dry season.

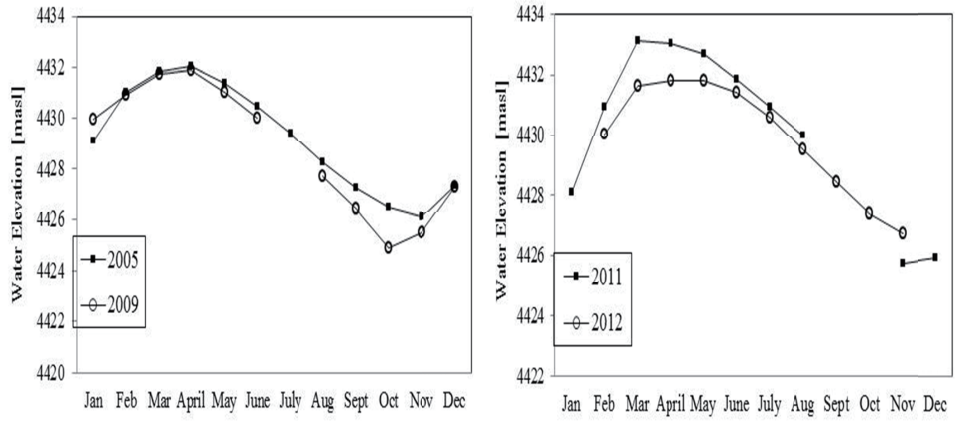


Fig. 2-3: Water Elevation in Lake Tuni (2005,2009,2011 and 2012)

Tuni River Mouth

Fig. 4-5 show the shoreline around the river mouth and the sandspit, which can be appreciated because in both cases November 2005 and August 2009 dry season is still present, and the water level. In the other hand for Fig. 6, which was taken in 2011, it cannot be seen the sandspit because the high level of the water, it shows just the shoreline shape. In May the water levels still being high due to this month is near to the raining season. Fig. 7 was taken in September 2012, month which is nearest to dry season than raining season.

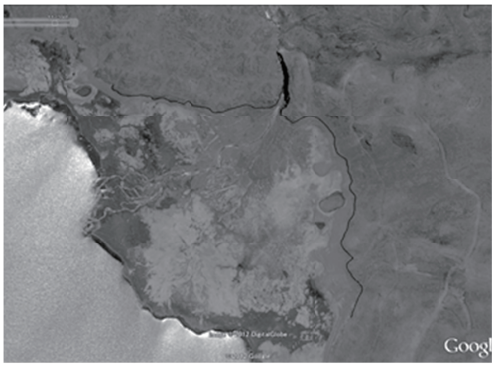


Fig. 4: Satellite Image Tuni River Mouth (November 2005)

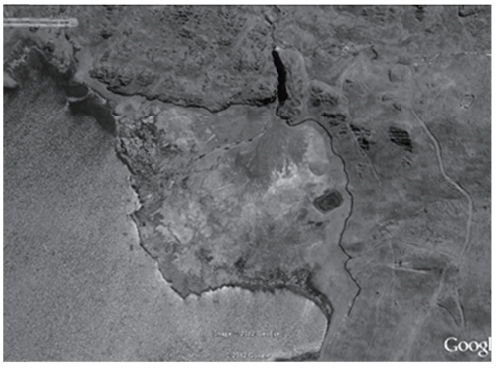
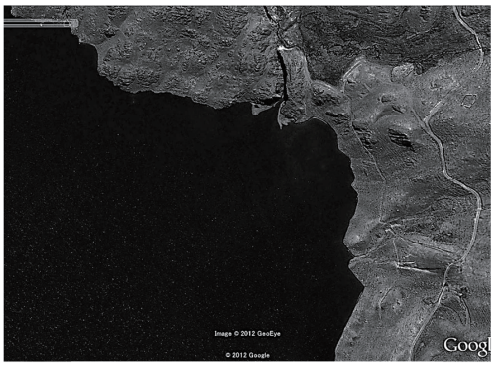


Fig. 5: Satellite Image Tuni River Mouth (August 2009)



Nameless River Mouth

Fig. 8-11 are satellite images which show the shoreline change for different periods of time around Nameless River.

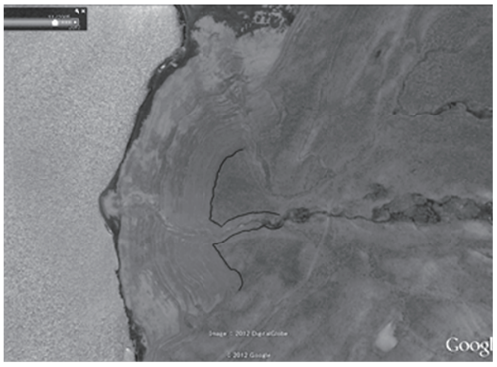


Fig.8: Satellite Image Nameless River Mouth (Nov- 2005)

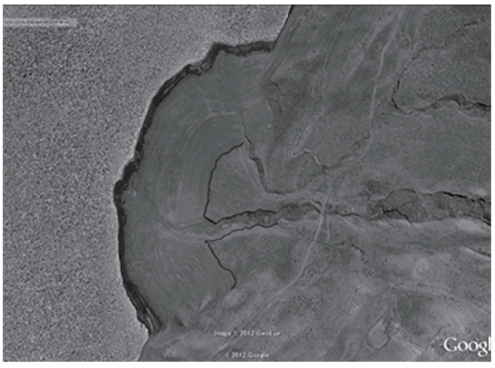


Fig. 9: Satellite Image Nameless River Mouth (August 2009)

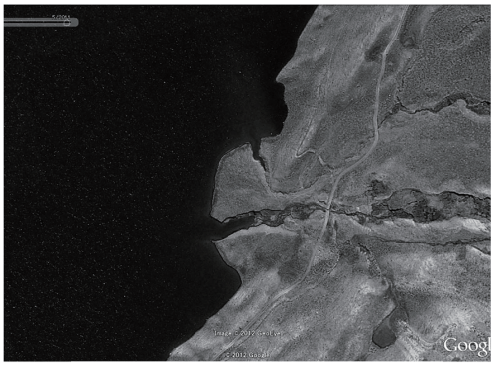


Fig. 10: Satellite Image Nameless River Mouth (May 2011)

Fig.11: Satellite Image Nameless River Mouth (Sep-2012)

In despite that Figure 8 was taken in November 2005 and Figure 9 in August 2009 the water level allow us appreciate quite similarity in the shoreline around the Mouth of Nameless River for both periods

In case of Figure 10, this image was taken in May 2011, the water level is high but it can be seen that the shoreline does not show important difference with previous periods analyzed.

Figure 11 was taken in September 2012, the water level does not allow appreciate the whole sandspit, comparing the shoreline around the river mouth, it can be appreciated differences with any of the other periods explained before.

Comparison

In order to make an accurate comparison between shoreline changes around the Tuni River Mouth and Nameless River Mouth respectively it was overlap the shoreline for the periods analyzed: 2005, 2009, 2011 and 2012 as it can be seen in Fig.12 -13.

In Tuni River (Fig. 12), it can be seen differences between 2011 and 2012 with 2005 and 2009 the shorelines, but it can be explained that it is because the images were not taken in the same season, nor with the same water level. Therefore it can be assumed that in Tuni River there is not remarkable erosive process.

In Fig. 13 it was analyzed Nameless River. In this case the influence of water level does not play an important role because it is clearly represented in the graph that there is no remarkable shoreline change. Also for this case can be assumed that the erosive process is not representative

Making a comparison with Lake Inawashiro of the erosive phenomena developed due to the existence of morphological similarities between the shoreline shape around the rivers.

Fujita & Tanaka (2002), showed through the topographical analysis of different periods a multiple sandspit development, establishing that the waves attack the shore with a large incident angle because of west-northwest winds that prevail during winter, concluding the wind impact as the main erosive factor.

In order to find the Wind Rose (Fig. 14), which represents the highest values of speed, wind information was analyzed monthly, quarterly, semiannually, and yearly.

However in Tuni Lake, examining the correspondence of Wind Direction, Wind Speed and sand movement it was found that; Due to Wind Direction is North North East direction (NNE), the fetch cannot have a remarkable erosive action over the shore, and the wind speed is low. analyzing the NNE direction as it is depicted in Table 2, 0.9 % of the wind data analyzed is bigger than 10 m/s. Also In Table 1 which is a resume of the whole data analyzed it can be seen that just 2.3% have velocity bigger than 10 m/s).

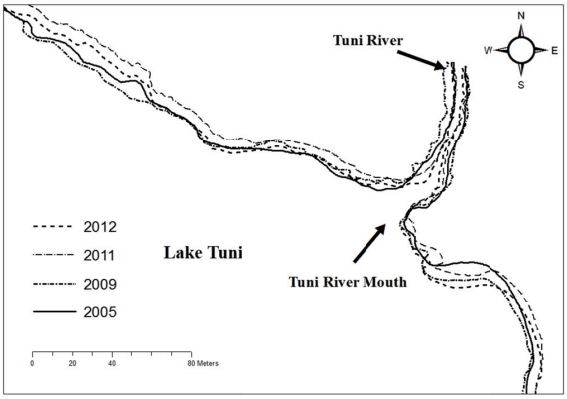


Fig. 12: Shoreline Change around Tuni River Mouth

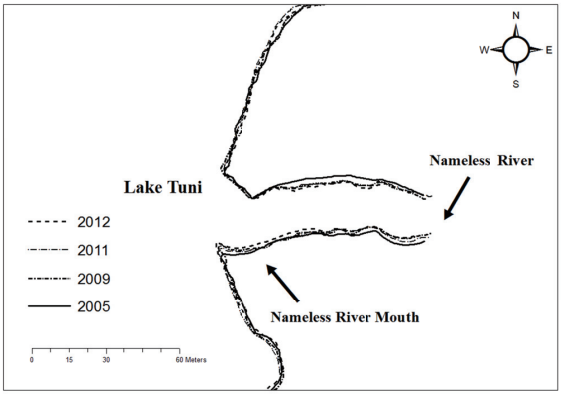


Fig. 13: Shoreline Change around Nameless River Mouth

Despite the analysis made in Lake Tuni have not counted with older periods as it was made in Lake Inawashiro, this appraisal bring and important perspective of the grade of erosive phenomena which is acting on the shoreline around of both River Mouths.

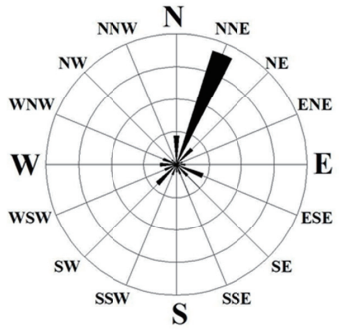


Fig.14: Wind Rose Lake Tuni

Velocity Range m/s	Average Percentage [%]
>10	2.3
7.5-10	11.5
5-7.5	22.6
2.5-5	25.6
1-2.5	22.5
0.5-1	8.2
<0.5	7.3

Table 2. Percentage [%] of Velocity Events

	>10	7.5-10	5-7.5	2.5-5	1-2.5	0.5-1	<0.5
	m/s	m/s	m/s	m/s	m/s	m/s	m/s
N	1.4	4.2	2.0	1.4	0.3	0.3	0.3
NNE	0.9	7.1	17.4	5.7	0.3	0.3	0.3
NE	0	0	2.7	1.2	3.0	0.2	0.5
ENE	0	0	0	0.6	0.7	0.2	0.2
E	0	0	0	1.0	1.0	0.2	0.2
ESE	0	0	0	4.8	2.1	0.3	0.3
SE	0	0	0	1.3	0.5	2.0	0.3
SSE	0	0	0	2.0	0.2	0.2	0.2
S	0	0	0	0.8	0.4	0.4	0.2
SSW	0	0	0	1.3	0.8	0.5	0.3
SW	0	0	0	2.4	3.9	0.2	0.5
WSW	0	0	0	1.4	1.5	0.2	0.2
W	0	0	0	1.3	2.1	0.5	0.5
WNW	0	0	0	0	2.5	0.6	0.6
NW	0	0	0	0	1.0	0.3	0.3
NNW	0	0	0	0	0.4	0.0	0.3

Table 1. Velocity percentage [%] related with Wind Direction

CONCLUSIONS

Despite the lack of meteorological data and based on satellite overlap graphs it can be said that neither River Tuni Mouth nor River Nameless Mouth develop important shoreline changes.

Fujita & Tanaka (2002) found the wind impact as a remarkable erosive factor on shoreline change process, but in Lake Tuni, wind does not have the same impact. The small impact is consequence of a low wind speed; in addition, the relationship between wind direction and fetch length does not contribute to the erosive phenomena.

ACKNOWLEDGMENTS

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