The evolution of the fluvial islets hydrodinamic shape.
Applications for Danube's Islets between Giurgiu and Oltenita towns

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Abstract. This paper presents a brief analysis on the fluvial islets hydrodynamic shape. Proposed by the Wyrick (2005) and Wyrick & Klingeman (2011), the hydrodynamic shape criteria refers "to the subaerial planform shape of the river islets". According to them, these geomorphological landforms can have a streamlined shape, an angular aspect or irregular shape. Except for the last category, each of the other types has several subtypes. For this case study we selected the fluvial islets from the Danube River, the sector situated between Giurgiu and Oltenita towns. It can be observed that, nowadays (2017) there are five new islets unlike between 1889 and 1916 and most of the river islets have an irregular shape. Also, in the literature it is mentioned that there might be a connection between the shape and age of islets. So, in our study, we applied a Chi-Square Test to check this relation. The results show that there is a possible association between the shape and the age of the Danube's Islets.

Keywords: hydrodynamic shape criteria, diachronic analysis, chi-square test, fluvial islets, Danube River.

1. INTRODUCTION

A fluvial islet is a landform, surrounded by stream channels, exposed during bank-full flows and with some stability, imposed by the presence of the permanent vegetation (Osterkamp, 1998; Wyrick, 2005; Wyrick & Klingeman, 2011; Picco et al., 2014; Picco et al., 2015). Islets are very important from morphological, ecological, economical or geopolitical points of view. Being part of the river system, they are strongly influenced by the hydrological parameters and by the human activities (Sadek, 2012; Picco et al., 2014; Marin & Armaș, 2016).

Fluvial islets have been extensively studied by the researches, under the issues of formation, evolution and classification (Machinov et al., 1986; Osterkamp, 1998; Gurnell et al., 2001; Wyrick, 2005; Gautier&Gravel, 2006; Zanoni et al., 2008; Ricaurte et al., 2012; Gao et al., 2013; Nicholas et al., 2013; Baubinienė et al., 2014; Kiss & Andrasi, 2014; Picco et al., 2014; Picco et al., 2015; Raslan & Salama, 2015). A great work in this regard was made by Wyrick (2005), who, in his PhD Thesis, addresses such a topic. In particular, he chose to investigate the relation between the river islets and the fluvial processes, including the connection between their shape and the hydro-geomorphologic phenomena manifested in the river channel. He also proposed an island classification scheme as a tool for improved river classifications and restoration actions. The classification scheme is inspired from Rosgen's (1996) objectives channel classification. The author proposed three basic categories of characteristics, which needs to be determined for each fluvial islet (Figure 1): i) Geometric – those that can be measured from cartographic documents or aerial/satellite images, ii) Biophysical – characteristics which can be measured/observed "in situ" and iii) Inferred – those that can be deducted from the other characteristics of islands and/or from a known history.
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Figure 1 The distinguishing characteristics of islands proposed by J. Wyrick (Wyrick, Klingeman, 2011)

The hydrodynamic shape criteria refers “to the subaerial planform shape of the river islets” (Wyrick, 2005; Wyrick & Klingeman, 2011) and as can be seen in the Figure 1, according to J. Wyrick, these geomorphological landforms can be classified as: i) islets with streamlined shape, ii) islets with an angular aspect and iii) islets with an irregular shape.

In this paper, we aim to identify and to show the evolution of the shape of Danube's Islets using the methodology proposed by the Wyrick (2005) in his PhD Thesis. For this case study we have selected the sector between the towns Giurgiu/Ruse and Oltenita/Tutran, Romania-Bulgaria (Figure 2). The length of the Danube study area is about 73 km and includes the romanian and bulgarian islets between 493 and 470 kilometers points.

2. METHODOLOGY

To investigate the shape of islets along the selected Danube River reach, we used the diachronic analysis. The fluvial landforms were observed: i) on ancient maps called Planuri Directoare de Tragere, which date from 1889-1916 and ii) on two sets of aerial and satellite images: ortophoplans of Romania from 2010 (5 m spatial resolution) and Sentinel 2A image from 2017 (10 m spatial resolution). The shapes of fluvial islets were visually determined by consulting the cartographic materials and images mentioned above.

Figure 2 Location of the Danube's Islets between the towns Giurgiu and Oltenita

To classify these landforms by their shape, we used the hydrodynamic shape criteria from the classification proposed by Wyrick (2005) and Wyrick & Klingeman (2011) (Figure 3).

Figure 3 Shape Category by J.Wyrick (2005) (Wyrick, Klingeman, 2011)
Because we found in the literature that there might be a connection between the shape and age of islets, we set the age of those landforms according to the appearance on maps and images. So, the islets that appear on all studied maps and aerial/satellite images are considered “old” and those which appear only on Sentinel 2A images are treated as “new”. It is important to mention that the age of the islets was determined based on another classification of Wyrick (2005): i) ancient islet, if it is older than 100 years and ii) new/recent islet, if it is younger than 10 years.

To evaluate the relation between the aspect and the age of fluvial islets, the Chi-Square test was applied, using SPSS software.

3. RESULTS AND DISCUSSIONS

The results obtained show that the Danube's islets between Giurgiu and Oltenita towns are classified into two major types: i) islets with a streamlined shape and ii) islets with an irregular shape. In the first category, predominant are the islets with lemniscate aspect, followed by the ones with elliptical and semi-circular shapes (Table 1).

In defining the shape of a fluvial islet, an important role is played by the age of the landform. The older the islet, the more it has been exposed to erosive-accumulative processes (Wyrick, 2005). In the Danube sector between Giurgiu and Oltenita towns five new islets were identified (Table 1): Elena Islet, Lung II Islet, Adite Islet and 2 islets without names. The Chi-Square test statistic applied in this study, indicate a possible association between the shape and the age of Danube's Islets (Chi-Square = 27.6, df = 10, p<0.002). So, the older islets, which have experienced more flows actions, tend to be irregularly shaped.

4. CONCLUSIONS

In the last 128 years (1889-2017), the fluvial islets of the Danube River have changed both in number and shape. If in the period 1889-1916, the number of islets with a streamlined shape (no = 6) was close to that of irregularly shaped islets (no = 5), at present (2010-2017) there are predominantly fluvial landforms with irregular aspect. Also, the applied statistical test showed a possible association between the shape and the age of Danube's Islets in the conditions where an islet is older, the longer it is subject to the actions of the water and sediment flow.

Table 1 Classification of the Danube's Islets between Giurgiu-Oltenita towns based on their shape

<table>
<thead>
<tr>
<th>NAME</th>
<th>SHAPE</th>
<th>1889-1916</th>
<th>2010-2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cioroiu</td>
<td>Streamlined - lemniscate</td>
<td>Irregular</td>
<td></td>
</tr>
<tr>
<td>Mocănașu</td>
<td>Irregular</td>
<td>Irregular</td>
<td></td>
</tr>
<tr>
<td>Mocanu</td>
<td>Irregular</td>
<td>Irregular</td>
<td></td>
</tr>
<tr>
<td>Aleko</td>
<td>Irregular</td>
<td>Irregular</td>
<td></td>
</tr>
<tr>
<td>Elena</td>
<td>There is no islet</td>
<td>Streamlined - lemniscate</td>
<td></td>
</tr>
<tr>
<td>Islet without name 1</td>
<td>There is no islet</td>
<td>Streamlined - elliptical</td>
<td></td>
</tr>
<tr>
<td>Lung</td>
<td>Irregular</td>
<td>Irregular</td>
<td></td>
</tr>
<tr>
<td>Lung II</td>
<td>There is no islet</td>
<td>Irregular</td>
<td></td>
</tr>
<tr>
<td>Mishka</td>
<td>Streamlined - elliptical</td>
<td>Streamlined - lenticular</td>
<td></td>
</tr>
<tr>
<td>Malkia</td>
<td>Streamlined - lemniscate</td>
<td>Streamlined - lemniscate</td>
<td></td>
</tr>
<tr>
<td>Goliam Brășlen</td>
<td>Irregular</td>
<td>Irregular</td>
<td></td>
</tr>
<tr>
<td>Adite</td>
<td>There is no islet</td>
<td>Streamlined - lenticular</td>
<td></td>
</tr>
<tr>
<td>Islet without name 2</td>
<td>There is no islet</td>
<td>Irregular</td>
<td></td>
</tr>
<tr>
<td>Islet without name 3</td>
<td>There is no islet</td>
<td>Irregular</td>
<td></td>
</tr>
<tr>
<td>Kalimok</td>
<td>Streamlined - lemniscate</td>
<td>Irregular</td>
<td></td>
</tr>
<tr>
<td>Radetski</td>
<td>Streamlined - lemniscate</td>
<td>Streamlined - semi-circular</td>
<td></td>
</tr>
</tbody>
</table>

REFERENCES


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