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Links between Selected Environmental Components and Flood Risk in the Danube Delta

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Abstract: The Danube Delta is the second largest delta in Europe after Kuban Delta. It is part of the Danube Delta Biosphere Reserve together with Razim Lagunar Complex and the Danube floodplain upstream the delta. It is located in the South-Eastern part of the Romanian territory. Its main components (as area extent and importance) are various water bodies. Water is the vital element for the people that live in deltas, as the water is used first of all for direct consumption, and then it offers the habitat for the major resource of the delta, and namely the fish. Water is also used for irrigation. In the same time water could be a permanent threat if we are referring to the socio-economic aspect of the environment. The flood risk is the most important issue affecting human activities. In order to have a better management of the environment components it is useful to analyse links between them and the flood risk. This paper presents a few elements of the Danube Delta's environmental characteristics, such as soil, landscape morphometry, land use and biodiversity, and it relates them directly to the flood hazard. Once the relations between these environmental elements and the flood hazard are known, mitigation measures could be proposed and planned in order to reduce or to eliminate the vulnerability of the elements to flooding. This can be included in the flood risk management plans that should be part of the spatial planning process in all areas, but especially in areas close to water bodies (stagnant or running waters).

Keywords: Danube Delta, flood risk, environmental elements, risk management

Introduction

In the last 20 years there has been an increase in extreme weather and water events because of climate changes caused by humans. As an example may be given the extreme hydrological events that occurred in the recent years. The first notable event was linked to hydrological events in 2003 when low water levels were recorded for the Danube River. On 6 September, 2003 at Ceatal Izmail a value of 0.737 m above Black Sea–Sulina level reference (rMNS) was recorded. Minimum discharge was recorded the day before and its value was 2060 m^3/s. The second hydrological event was one regarding particularly high water levels of the Danube River. In 2006, on April 26-27th, at Ceatal Izmail, there was a water level of 5.4 m over the rMNS and a water discharge about 16 440 m^3/s. Moreover, on April 26 there was a level of 4.93 m rMNS at Tulcea station. A third important hydrological event refers to the high water levels of the Danube in 2010: at Isaccea, on July 6th, was recorded a level of 6 m over rMNSm and 4.95 m over rMNS at Tulcea, which was with 2 cm more than in 2006 (Mierla, Romanescu 2013).

Extreme events, which occur with a higher frequency, demonstrate the presence of an imbalance created over time between different components of geo-systems. Soceava (1975) identifies geo-system as an open system, a whole that is composed of interrelated elements of nature, subject to its laws. It suffers from the most diverse influences of human society that disturb the wholeness of the system considerably. These influences affect the structure of natural processes and thus provide a new quality for geo-systems (Rosu 1987).

The term risk takes into consideration the anthropic element. Defining and assessing these risks are done with direct and indirect monitoring of the condition of human society. In the absence of human society changes, "the risk" is nothing more than various forms of movement of a balance in one direction or another, a fact which is very common in natural systems: changing seasons, increases and decreases of rivers water levels, the day/ night rhythm, etc. (Mierla, Romanescu 2013). The simplest definition of risk is that risk is "the product of hazard and vulnerability" (Romanescu 2009, Stanga 2007). Risk is a quadratic function of hazard and vulnerability. Graphical representation of it shows that it is a second-order exponential function of hazard and vulnerability (Romanescu 2009, Stanga 2007).

The flood affects all environmental components including soils, landscape morphometry, land use, biodiversity and others. All these components are parts of a system that operates due to the interaction between them. These interactions are in equilibrium, a fact that determines the good status of the system. When a component is in excess then this system is not at the good level functionality.

Material and Methods

In order to establish the link between floods and the environment, and the intensity of this link, it was necessary to use data regarding different environmental components. These data were mostly spatial data with some attributes that give more details regarding the elements of the environment, taking into account that there were different individuals in the same class of environmental elements. The second dataset that was utilised for this paper consisted of spatial data regarding flooding phenomena (to be more precisely the data regarding the flood hazard) (Fig. 1). For the last mentioned datasets there were three kinds of data as follows: the first one was representing the extent of the 30 year-flood, the second was about the extent of the 100 years-flood and the third one was about the 1000 years-flood. These data were obtained within the CARTODD project.

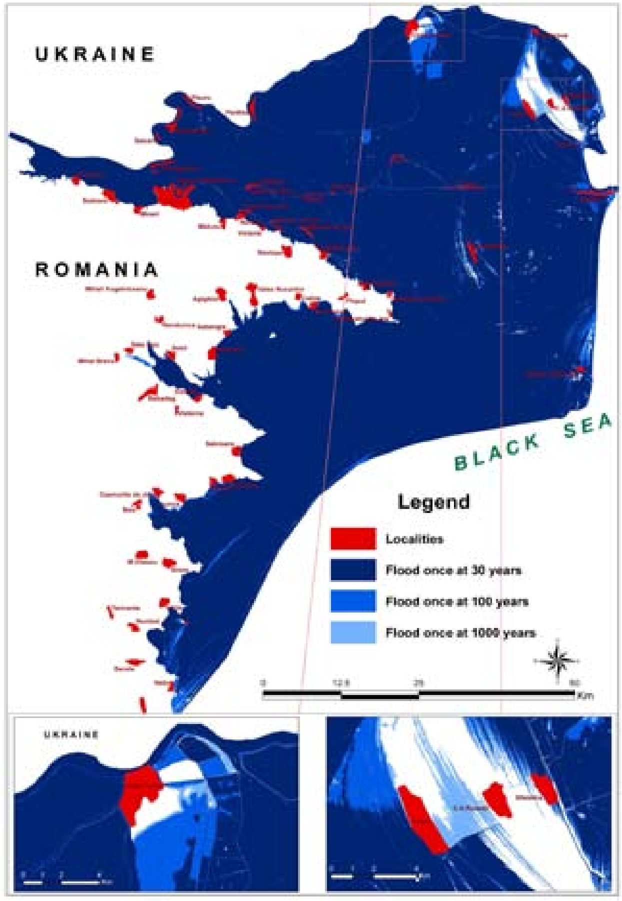

Fig. 1. Flood extent at different probabilities within Danube Delta Biosphere Reserve

From the first dataset only the soils and land cover data covering the entire Danube Delta Biosphere Reserve (DDBR) were included into the analysis. In Fig. 2 the map of soils of DDBR with all its types can be observed.

The third dataset used with regards to the environment was the Land Cover (Fig. 3). It was extracted from the Corine Land Cover datasets from 2000, obtained by downloading from the European Environmental Agency (EEA).

The method was based on the fact that at different extents of flood, different surfaces with different composition of elements were present. In order to uncover this, spatial analyses were conducted with the help of Geographical Information System (GIS) tools. The established link between data of environmental components and the flood hazard was made through taking into account the surface extent of the selected elements within the extent of the flood hazard surfaces for different probabilities.

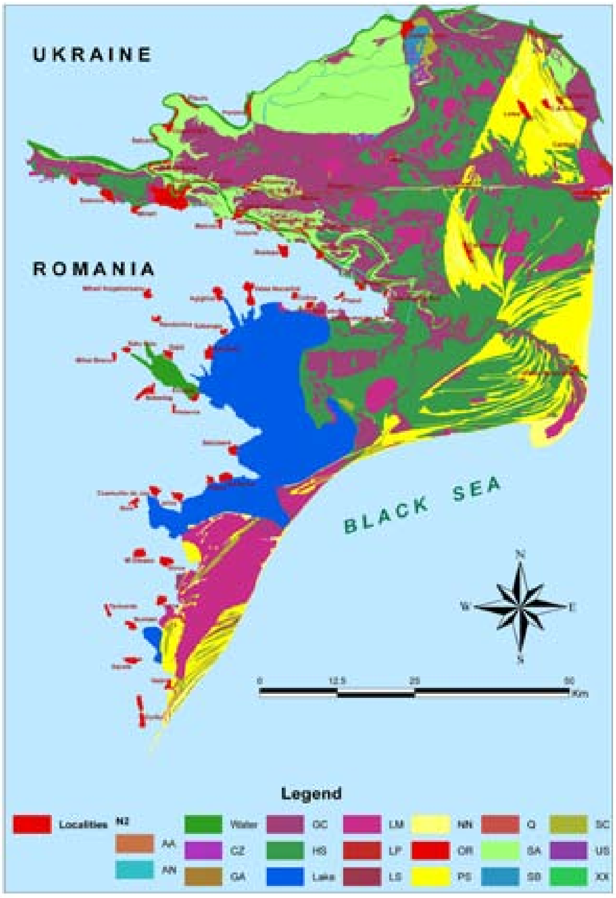

Fig. 2. Soil types in the Danube Delta Biosphere Reserve

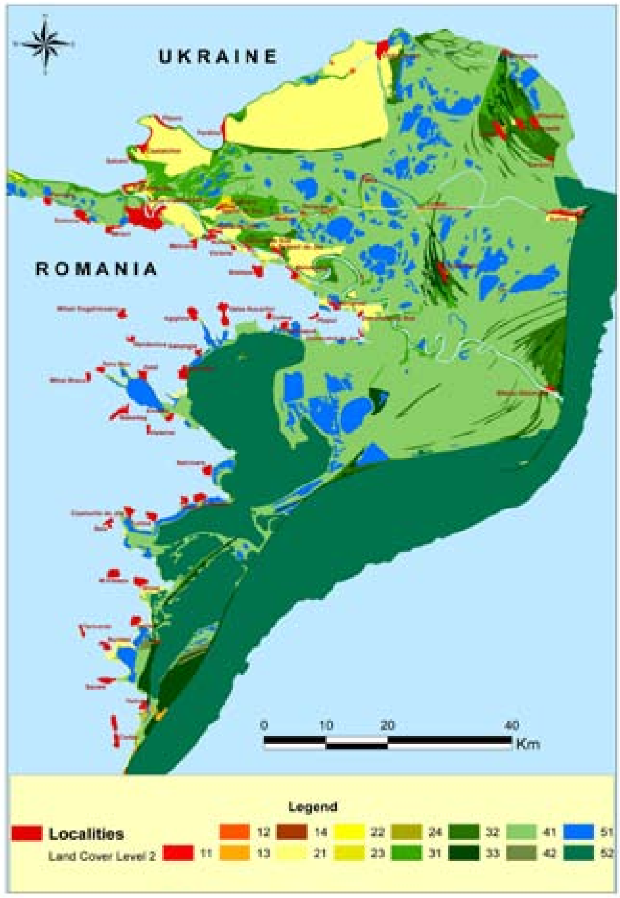

Fig. 3. Land cover in the Danube Delta Biosphere Reserve. The legend for the third figure can be read in the table below (Table 1) taken from the European Environmental Agency (EEA)

Table 1. The CLC nomenclature at second level for the area of interest (Danube Delta Biosphere Reserve) (EEA)

CLC codes	Level 2 (CLC meaning)
11	Urban fabrics
12	Industrial, commercial and transport units
13	Mine, dump and construction sites
14	Artificial, non-agricultural vegetated areas
21	Arable land
22	Permanent crops
23	Pastures
24	Heterogeneous agricultural areas
31	Forest and semi natural areas
32	Scrub and/or herbaceous
33	Open spaces with little or no vegetation
41	Inland wetlands
42	Coastal wetlands
51	Coastal waters
52	Marine waters

Results and Discussion

Taking into consideration the fact that both datasets (those with the environmental components and the ones regarding the flood) had the same spatial co-incidence, we applied the technique known as data intersection. As a result of this data intersection, we obtained a new dataset that had different proportion of surface from the total for each category of the environmental component, additionally taking into account the extent of the flood of different probabilities. We estimated the percentage of the surface for each soil type within the flood extent with different probabilities (Table 2).

The different values of the surface percentage per each soil type (presented in Table 2) illustrated the fact that there were several soil types that were more affected by floods with high probabilities (*e.g.* once every 30 years). In addition, there were other types that were more affected at small probabilities (once every 1000 years) (Fig. 4).

Table 2. Percentage of different soil types surface for different flood probability

Nr.	codes	Soil Types	percentage 30 y	percentage 100 y	percentage 1000 y
1	AA	Gleyc-Calcaric Fluvisols	0.21	0.14	0.11
2	AN	Cumulic Anthrosols	0.33	0.29	0.27
3	CZ	Gleyic-Calcaro-Calcic Chernozems	0.17	0.13	0.23
4	GA	Marshy-Fluvic-Eutric Gleysols	0.08	0.10	0.07
5	GC	Gleyic-Eutric Fluvisols	22.67	22.66	23.43
6	HS	Terric-Thionic and Thionic Histosols	25.10	24.15	30.74
7	LM	Coprogenic Limnosols	13.28	14.06	12.95
8	LP	Calcareous Muddy Limnosols	0.01	0.01	0.00
9	LS	Gleyic-Calcaric Psamosols	0.17	0.18	0.06
10	NN	Shifting Sands and Calcaric Psamosols	2.03	2.77	1.63
11	OR	Main Localities	0.15	0.23	0.08
12	PS	Marshy Semisubmerged-Mollic Arenisols	19.80	19.06	13.92
13	Q	Shifting Sands	0.05	0.05	0.02
14	SA	Calcaric Fluvisols	13.45	13.12	14.05
15	SB	Vermi-Calcaro-Calcic Kastanozems	0.27	0.55	0.38
16	SC	Gleyic-Mollic Solonchaks	2.16	2.37	1.98
17	US	Tulcea town suburbia	0.05	0.04	0.01
18	XX	Secondary Localities	0.03	0.09	0.05

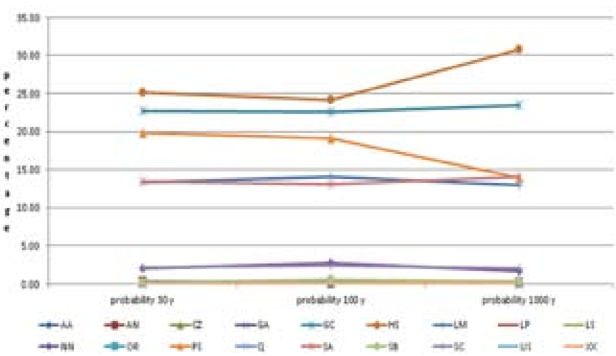

Fig. 4. The percentage of soil types surface at different flood probabilities

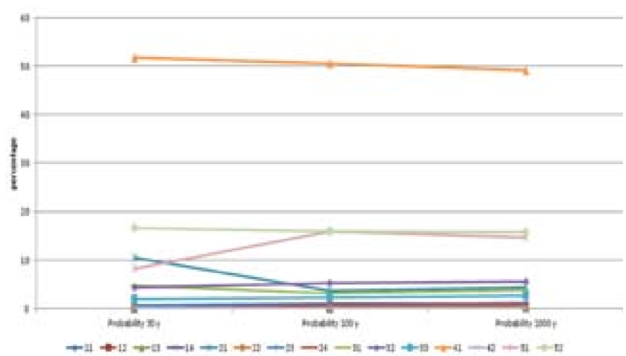

Fig. 5. The percentage of the surface of Land Cover at different flood probabilities (once at 30 years, at 100 years and at 1000 years)

The increase in the percentage organic soils surface affected by flood (depending on the flood probability) was happening in the same time with the decrease of the psamosoils surface percentage for different flood percentage. This fact demonstrated that psamosoils were at a lower altitude than the organic soils. Therefore, at high water levels a bigger percentage of the organic soils would be affected by floods.

It was well observed (Table 3) that the arable land at high flood probability (once at 30 years) had a big percentage from the total surface. After that the percentage of this proportion of land cover significantly decreased for the 100 years flood probability. But for the 1000 years flood probability the percentage was increasing due to the fact that in the Danube Delta Biosphere Reserve there were arable lands on higher ground. The tendency of the land cover surface percentage could be explored by reading Fig. 5.

At the same time the percentage of the inland waters decreased for the same reasons (the low altitude of their position). Coastal waters registered an increase owing to the fact that they were far from the concentration of the freshwaters. Their position was where the force of the flood was diminishing. The other elements were in equilibrium that allowed us to conclude that in their cases the stability meant that they were affected all the time in the same amount or they were never affected more or less. This could

Table 3. The percentage of the Land Cover codes surface at different flood probabilities

Nr. Crt.	Land Cover codes	Percentage 30 y	Percentage 100 y	Percentage 1000 y
1	11	0.62	0.97	1.05
2	12	0.10	0.11	0.33
3	13	0.04	0.07	0.09
4	14	0.03	0.14	0.15
5	21	10.43	3.60	4.42
6	22	0.28	0.33	0.34
7	23	0.53	0.74	1.20
8	24	0.06	0.77	0.92
9	31	4.65	3.22	3.87
10	32	4.41	5.20	5.56
11	33	1.99	2.31	2.58
12	41	51.79	50.63	49.14
13	42	0.15	0.07	0.01
14	51	8.26	15.99	14.62
15	52	16.66	15.87	15.72

be established by taking into account the values of the land cover surface percentage. If the percentage did not change too much, this indicated that that land cover was affected in a constant way.

All the environmental elements were linked between them and a potential disequilibrium registered in one of these elements could cause disequilibrium for other elements. Knowing this relation between different environmental elements could assist the human society in integrating better in the environment, following in a stronger way the concept of "sustainable development".

References

Mierlă M., G. Romanescu 2013. Hydrological flood risk assessment for Ceatalchioi locality, Danube Delta. - *Works of Geographic Seminar "Dimitrie Cantemir"*, Iasi, Romania, **36**.

Romanescu G. 2009. Evaluarea riscurilor hidrologice, Editing House "Terra Nostra", Iasi, Romania.

Roșu A. 1987. Terra - geosistemul vieții, Scientifically and Encyclopedic Editing House, Bucharest, Romania.

Soceava B. V. 1975. Geosistemul: concept, căi de clasificare, Studii şi Cecetări Geolog., Gefiz., Geogr., seria Geografie, t. XXII.

Stângă I. 2007. Riscuri naturale. Noţiuni şi concepte,"Alexandru Ioan Cuza" University Editing House, Iasi, Romania.