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Danube Delta Biosphere Reserve (D.D.B.R.): reed dynamics within actual context

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Abstract. The reed beds are widely considered in Europe as ecologically and economically beneficial areas. In The Danube Delta Biosphere Reserve (D.D.B.R.), reed is by far the dominant species and reed marshes cover more than 220,000 ha (Hanganu et al 2002). Presently, certain areas of reed beds are selected for burning or harvesting during the winter by private companies. Other surfaces are harvested in green, mown by the inhabitants as cattle food. Comparing the present period with the harvest campaigns from the '60th until the '80th, we can say that the actual pressure on reed's biodiversity is reduced. All above aspects of management practices and their influence on reed beds succession and conservation of biodiversity are discussed. Beside the current reed type description and comparison with biometrical data from Chifu et al (1993), we present their distribution, in relation with type of substrate and hydrology, by reed complexes.

Key Words: Danube Delta, reed beds, harvest, dynamics.

Rezumat. Stufărişurile sunt unanim considerate în Europa ca fiind areale importante de interes ecologic şi economic. În Rezervaţia Biosferei Delta Dunării (R.B.D.D.), stuful este cu siguranţă specia dominantă, zonele stuficole acoperă mai mult de 220,000 ha (Hanganu et al 2002). În prezent, anumite suprafeţe de stuf sunt selectate pentru ardere sau recoltare în perioada de iarnă de către companii private. Alte suprafeţe sunt recoltate în verde, cosite sau utilizate pentru păşunat de către localnici. Dacă facem o comparaţie între perioada actuală şi cea a campaniilor de recoltare a stufului din anii '60 - '80 este lesne de înţeles că presiunea asupra biodiversităţii stufărişurilor a scăzut. Toate aspectele cu privire la practicile de management menţionate mai sus şi influenţa lor asupra succesiunii stufărişurilor, precum şi cele de conservare a biodiversităţii, vor fi dezbătute. Pe lângă prezentarea tipurilor actuale de stufărişuri care vor fi comparate biometric cu datele după Chifu et al (1993), vom indica răspândirea acestora după tipul de substrat şi regimul hidrologic, pe zone stuficole.

Cuvinte cheie: Delta Dunării, stuf, recoltare, dinamică.

Introduction. According to Charles Hartley map from 1886, the Danube Delta was divided in four islands of reed (Ceatal, Letea, Sf. Gheorghe and Dranov) and reed marshes look to be more extensive than nowadays. First available data about harvesting practice in Danube Delta relieve that Gr. Antipa in 1908 opened a cellulose factory in Brăila and later, in 1942 was setting up a law and a work paper concerning the capitalization of reed-beds and reed mace areas. The '60th until the '80th is considered the most intense reed harvest period. L. Rudescu classified in 1965, the reed areas in four groups containing 10 biotopes. In 1993, T. Chifu and his collaborators established 7 reed types with 7 subtypes suitable for harvesting. Combined with these data J. Hanganu set up in 2002, 9 reed eco-types from which, 5 are suitable for harvesting purposes. Our review of 8 years research (2002 – 2010), includes information on the main economically capitalized resource (reed) categorized in these 5 reed eco-types (Hanganu et al 2002). Also, it is presented the estimation of reed harvesting potential in order to lease sustainable exploitation activity within the following reed-beds areas: Şontea – Fortuna; Matiţa – Merhei; Magearu; Gorgova – Uzlina; Erenciuc; Roşu – Puiu; coast line Sulina – Sf.Gheorghe sector; Holbina – Dranov; Zmeica – Goloviţa; Sinoe; Buhaz; Somova – Parcheş; Başcealâc – Enisala and Crişan.

Material and Method. Being given the Danube Delta's statute of Biosphere Reserve, the calculation of the harvesting reed amount needed certain modifications mentioned below; the classical methodology has been adapted to the new conditions.

Thus, for biodiversity protection, 25% of each leased area must not be harvested. Generally, this percentage is represented by areas more difficult to access to or by reeds with lower productivity. In calculating the harvesting reed amount it is also considered the harvesting waste representing 10-20%, depending on the harvest methodology (either manually or mechanically) and 10% representing shaping waste. Therefore, the harvesting reed amount, on which management measures have been applied, is only 45% out of the reeds productivity within an area.

The harvesting reed amount is influenced by the management measures (so that, depending on burning or non-intervention and the presence of two generations, the productivity may be reduced up to 90%), and the more exact evaluation of the harvesting amount within an area can be done at the beginning of each harvest campaign. This evaluation has to be carried out for all areas where reed resource leasing is requested. To plan and prepare the evaluation actions of the harvesting production it is necessary that the leased areas to be known approximately two months before the harvest campaign and the financial resource for the harvest campaign must be prepared a long time before.

The estimation of the sustainable reeds exploitation has been done by teledetection and field trips (Hanganu et al 1995-2002; Hanganu et al 1997). Recent TM Mapper satellite images have been selected for the studied area. To calibrate the satellite image pixels that correspond to reed vegetation field trips have been carried out in the reeds within each reed area proposed for leasing. The selection of the stations where reed samples were to be collected has grounded on the following principles:

- pixel structure (value, chrome) of the satellite image to be homogenous and representative for the reed type of the area;
- the number of the pixels with the same structure (value, chrome) to be higher than 8 in order not to suffer from interference of the surrounding areas;
- reeds have to be homogenous from density and height point of view.

After calibrating the satellite images pixels on the field and describing the reed types, the supervised processing of the satellite images has been carried out by using Arcview soft and an appropriate computer, to establish the harvesting reed areas, to locate the checking field samples and to organize the information.

Within each selected point, according to the principles mentioned above, reed samples have been collected. Each sample consisted of four randomly chosen sub-samples. The sub-sample area was 0.250 m^2. Total biomass, green stem biomass, height, stem base diameter and panicle basis diameter have been established for every sample. The results have been referred to 1 m^2.

In order to establish humidity, stem and panicle samples of the latest generation have been collected. Humidity samples have been weighed in the field and then dried in the sterilizer (80^0C) in laboratory up to a constant weight in order to establish the dried weight.

To calculate the harvesting reed amount, the total biomass resulted after drying at 80°C has been referred to biomass reed/m^2 with a humidity of 15% which is considered to be the standard for beneficiary delivery. To this value, above mentioned deductions have been applied, in order to have the necessary insurance to support biodiversity, harvest waste, shaping waste and management measures. Finally, the result is the actual harvesting amount which, referred to its corresponding surface (ha), represents the real productivity of the area (ha).

Results and Discussion. The potentially harvesting monodominant reed has been classified (at the same time with the research for the vegetation map) in 5 eco-types (depending on the biometric particularities and on the soil substrate type): reeds on gleic soils, reeds on peat gleic soils, reeds on compact floating reed islet, reeds on psamosoils and reeds on salinized organic soils. The reeds identified during field trips as belonging to one of the mentioned types, depending on the biometric particularities and the accompanying flora, display closely related values. This fact makes field investigation much easier. The detailed features of each type of reed are shown below:

Table 1

Biometric characteristics (average*) of the harvesting reed
(Hanganu et al 1995-2002)

Vegetation map symbol	*S-F*	*S-Ft*	*S-Ps*	*S-N*	*S-Pa*
Height (m)	2.9	2.7	2.35	2.5	2.2
Stems diameter (mm)	11	9.7	10.2	9.5	8
Density (stems/m²)	57	52	43	73	135
Stems biomass (kg. d.s./m²)	1.66	1.50	0.91	1.63	1.49

*deviation from average: 20%

1. The type of reed on gleic soils (S-F), where *Phragmites australis* has an average coveringof 90%, having *Cladium mariscus, Mentha arvensis, Scutellaria galericulata, Galium palustre* as recognition species.

Reed populations have an average density of 57 individuals /m^2, an average height of 2.9m, the average stem base diameter of 1.10 cm and the average biomass of 1.66 kg d.s. /m^2, representing 92% out of the total biomass of the type which is 1.8 kg d.s/m^2. Reed stems represent 72% and leaves represent 19% of the total reed biomass.

2. The type of reed on peat gleic soils (S-Ft), where *Phragmites australis* has an average cover of 80% and *Symphytum officinale, Schoenoplectus lacustris, Solanum dulcamara*, *Lycopus europaeus, Lythrum salicaria* are recognition species.

Reed populations have the average density of 52 individuals/m², an average height of 2.7m, the average stem base diameter of 0.97 cm ant the average biomass of 2.05 kg s.u./m². The type consists of a total biomass of 2.12 kg d.s. /m² on average, out of which the reed stems represent 71% and the leaves 20%.

3. The type of reed on compact floating islet, on hemic organic soils (S-Ps), where *Phragmites australis* has an average cover of 80% and *Mentha aquatica, Senecio paludosus, Rorippa amphibia* are recognition species.

Phragmites australis phytopopulations have an average density of 43 individuals /m, average height of 2.35m, average base stem diameter of 1.2 cm and average biomass of 1.14 kg d.s. /m². The total biomass of the type is 1.22 kg. d.s. /m², out of which reed stems represent only 75 % and the leaves approx. 18%.

4. The type of reed on psamosoils (S-N), where *Phragmites australis* has an average cover of 90% and *Calystegia sepium, Lysimachia vulgaris, Alisma plantago-aquatica, Ranunculus lingua* are recognition species.

Reed population have the average density of 73 individuals /m², average height of 2.51m, average base stem diameter of 0.95 cm and the total biomass 2.30 kg d.s. /m², out of which the reed stems represent 71 % and the leaves 22%.

5. The type of reed on salinised organic soils (S-Pa) are characterized by an average density of the reed stems of 135 individuals/m², average height oh 2.2m, average base stem diameter of 0.8cm and the total biomass 2.3 kg d.s. /m², out of which the reed stems represent 65 %.

Furthermore we present the reed eco-types and biometrical data for each harvesting reed area (see also the map in Figure 1).

Harvesting reed area no. 1, Şontea-Fortuna, covers almost the entire lakeside complex, except the forest polder Pardina, between Sulina Branch and Păpădia Brook. Within Şontea-Fortuna area, 3 types of unequally distributed reed can be found: on gleic soils (fluvial deposits) 75.8 % of the surface; on peat gleic soils 17.9 % and on compact floating islets 6.3%. The reed harvesting area is approximately 5,750 ha and the reed harvesting quantity is 5,175 tones.

The reeds on gleic soils, which are dominant within this reed area, have an average density of 50±9 green stems/m^2, an average stem height of 330±60 cm, base stem diameter 9.5±2 mm, and the total stem biomass of the last generation sums up approx. 1,270±145 g/m^2.

Harvesting reed area no. 2*,* Matiţa-Merhei, covers the central part (including Merhei Lake) and the south part of the depression to the big M of Sulina Arm. The depression is characterized by slight siltation and wide areas with reeds (Diaconu & Nichiforov 1963) well-developed on compact floating islets. In the case of this area, reeds distribution depending on sub layer is unequal, reeds on compact floating islets being dominant (76.8% out of the harvesting reed area). The reeds on gleic soils cover 11.3 % of the harvesting area no.2, the reeds on peat gleic soils cover 6.5 % and the reeds on psamosoils cover 5.4 % the harvesting area is approximately 5,510 ha and the harvesting amount is 4,959 tones.

The reeds on compact floating islets have a density of 40±14 green stems/m^2, and the average stem height of 425±30 cm, stem diameter 8±2 mm and stem total biomass of the last generation sums up approx. 910 g/m^2.

Harvesting reed area no. 3*,* Magearu*,* lies in the depression Magearu-Sulina, at the southern Letea Sandbank. The alternation of wetlands and sand areas determines the existence of compact reed areas mixed with elongated strips of psamo-halophyle grasslands. The ground-water layer is salinized and the low altitude allows, during storms, sea water to reach within the depression. As in the case of the previously mentioned area, reeds on compact floating islets are dominant – 83.3 % out of the total harvesting reed area. Reeds on psamosoils cover the rest of 16.7 %. The harvesting area is approximately 6,900 ha and the harvesting amount is 6,210 tones.

The biometric particularities of the dominant reed in the area are: density 60±8 green stems /m^2, average stem height 350±53 cm, stem diameter 7±1.5 mm and total biomass of the last generation stems approx. 1,100±220 g/m^2.

Harvesting reed area no. 4*,* Gorgova-Uzlina, lies in the eastern part of Litcov depression, limited by Sulina branch in the north and by Sf. Gheorghe branch in the south-east. The same as the reed area Şontea-Fortuna, this area has a slight draining and is characterized by wide areas of compact reed with small leaved reed mace (*Typha angustifolia*) and Dutch rash (*Bolboschoenus maritimus*). In the area Gorgova-Uzlina, there are 4 types of reeds. The harvesting reed area is covered almost equally with reeds on peat gleic soils representing 43.4% of the surface and reeds on compact floating islets with a higher cover percentage- 45.7 %. The reeds on psamosoils cover 8.3% and the reeds on gleic soils (fluvial deposits) cover 2.6 %. The harvesting reed area is 8,460ha and the harvesting reed amount is 8,460 tones.

The reeds on compact floating islets (dominant in the area) have a density of 78±10 green stems /m^2, and average stem height 375±27 cm, base stem diameter 9±2 mm and the total biomass of the last-generation stems sums up approx. 1,650±240g/m^2.

Harvesting reed area no. 5, Erenciuc, is relatively a reduced area, compact and is situated in the southern part of Caraorman Sandbank within Erenciuc depression. The distribution of the reed types is relatively balanced: the reeds on gleic soils (fluvial deposits) cover 42.6%, the reeds on compact floating islets 37.2% and the reeds on peat gleic soils 20%. The harvesting area is 1,900 ha and the harvesting reed amount is 1,520 tones.

The reeds on gleic soils (fluvial deposits), dominant within this reed area, have a density of 68±10 green stems/m^2, an average stem height 235±32 cm, base stem diameter 4.2±1.8 mm and the total biomass of the last-generation stems sums up approx. 850± 100g/m^2.

***Harvesting reed area no. 6**,* Roşu-Puiu, lies between east of Caraorman sand dunes and Erenciuc depression, between northern Sulina branch and southern Sărăturile sand dunes. This depression has the widest surface in the fluvio-maritime delta. As it is an area with wide-surfaced lakes, the dominant reed type is on compact floating islets-57.3% out of the harvesting reed area no 6. The reeds on acid organic or/and salinized soils cover 39 % and the reeds on psamosoils cover 3.7 % of the surface. The harvesting reed area is 4.360 ha and the harvesting reed amount is 4.796 tones.

The dominant reeds have the density 60±10 green stems/m^2, an average stem height of 200±25 cm, stem diameter 4.7±2 mm and the total biomass of the last-generation stems sums up approx. 1,000±220g/m^2.

Harvesting reed area no. 7, Coastline, is the maritime area opposite the delta, the maritime section between Sulina and Sf. Gheorghe. This section has a weak influence of Danube waters and is high influenced by the existence of certain relatively strong maritime currents (Diaconu & Nichiforov 1963). The proximity with coastline area determines the dominant reeds. The dominant reeds are acid organic or/and salinised soils (94.2%), reeds on compact floating islets with a low percentage (4.3 %), and the rest (1.5%) are reeds on psamosoils.

The harvesting reed area is 690ha and the harvesting reed amount is 1,380 tones. The biometry characteristics of the dominant reed are: the density 195±27 green stems /m^2, an average stem height of 259 ± 30 cm, base stem diameter 3.5 ± 1mm and the total biomass of the last-generation stems sums up approx. 2,600 ± 300g/m^2.

Harvesting reed area no. 8, Holbina – Dranov, lies within Dranov depression, in the proximity of Lake Razim at the west, Dunăvăţ Cannal at the north, Sf. Gheorghe branch at the east and Tărâţa Canal at the south. Reeds distribution according to substrate layer is unequal. Reeds on compact floating islets are dominant - 43.2% out of the harvesting reed area. Important percentage have reeds are acid organic or/and salinized soils (32.1%) and reeds on peat gleic soils (20.4%), the rest of 4.3 % are reeds on gleic soils.

The harvesting reed area is 8,100 ha and the harvesting reed amount is 8,100 tones. The reeds on compact floating islets (dominant in the area) have the density of 103±10 green stems /m^2, an average stem height of 210±30 cm, stem diameter 3.1±1.4 mm and the total biomass of the last-generation stems sums up approx. 1,200 ± 200g/m^2.

***Harvesting reed area no. 9**,* Zmeica-Goloviţa, is limited in southern part by Lake Goloviţa, around Lake Zmeica, in north-western part by Lake Ceamurlia and in eastern part by The Black Sea in Portiţa area. The position in the litoral line of this reed area determines the reeds structure as follows: reeds on acid organic or/and salinized soils – 83.5% of surface, reeds on psamosoils – 16 % and a reduced percentage of reeds on compact floating islets - 0,5 %.

The harvesting reed area is 1.880 ha and the harvesting reed quantity is 4.136 tones. The dominant reeds in the area (reeds on acid organic or/and salinized soils) have a density of 293±20 green stems/m^2, an average stem height of 194±35 cm, base stem diameter 3.8±1.8 mm and the total biomass of the last-generation stems sums up approx. 1.400±200g/m^2.

***Harvesting reed area no. 10**,* Sinoe, is situated on the western shore of Lake Sinoe, around Lakes Tuzla, Nuntaşi and Istria. Within Sinoe area, there occurs only reeds on acid organic or/and salinized soils. The harvesting reed area is 800 ha and the harvesting reed amount is 1.600 tones. The dominant reeds in the area have the density 352±20 green stems /m^2, an average stem height of 215±25 cm, base stem diameter 4.1 ± 2 mm and the total biomass of the last-generation stems sums up approx. 1.500±210g /m^2.

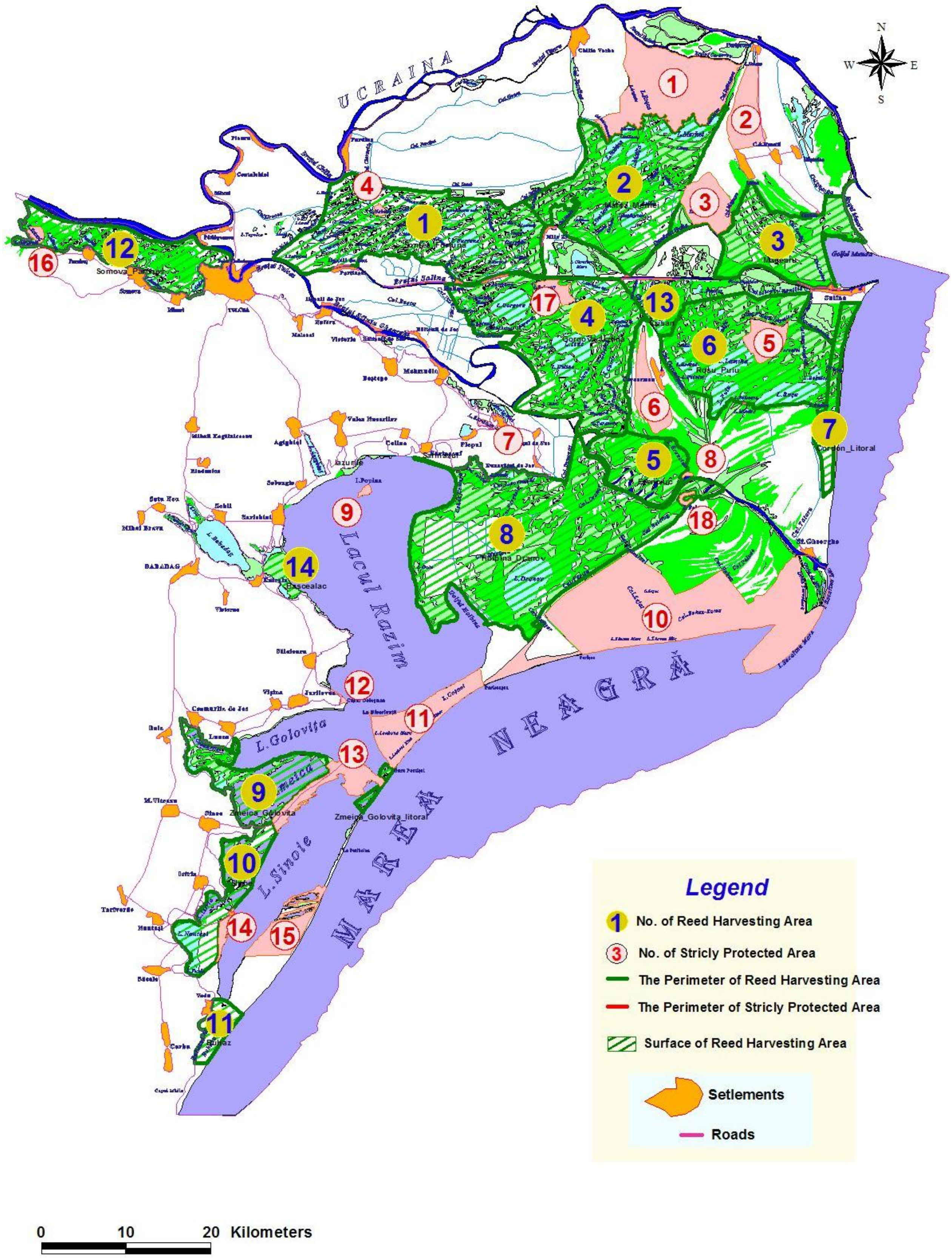

Figure 1. The map distribution of reed harvesting areas

Harvesting reed area no. 11, Buhaz, is a compact area displayed between Vadu locality and The Black Sea shoreline, in south up to Corbu locality. Within Buhaz area there are only reeds on acid organic or/and salinized soils. The harvesting reed area is 350 ha and the harvesting reed amount is 980 tones. The biometry characteristics of the dominant reeds in the area are: the density 110±22 green stems/m^2, an average stem height of 135±27 cm, base stem diameter 4.2±1 mm and the total biomass of the last-generation stems sums up approx. 1,110±240 g/m^2.

Harvesting reed area no. 12, Somova – Parcheş, is a reed area situated in avant-delta and is displayed from the east (Lake Rotund area) to the west (the limits of Tulcea locality) along Danube. Within Somova-Parcheş area, reeds on compact floating islets are dominant (87.7% out of entire the harvesting area), the rest of 12.3% are covered by reeds on gleic soils. The harvesting reed area is 1,300 ha and the harvesting reed amount is 1,170 tones. The biometry characteristics of the reeds on compact floating islets (dominant reeds in the area) are: the density 68±15 green stems/m^2, an average stem height of 230±30 cm,base stem diameter 8.7±2 mm and the total biomass of the last-generation stems sums up approx. 800±200 g/m^2.

Harvesting reed area no. 13, Başcealâc – Enisala*,* is enclosed on the west shore of the Razim-Sinoe complex in Japşa Grădiştea, in the proximity of Enisala borough at the west and Taşburun hill at the south. Within the Başcealâc - Enisala area, there are reeds on acid organic or/and salinized soils. The harvesting reed area is 948 ha and the harvesting reed amount is 940 tones. The biometry of the reeds on acid organic or/and salinized soils (dominant reeds in the area) is: the density 57±16 green stems/m^2, an average stem height of 280±30 cm, base stem diameter 9±2 mm and the total biomass of the last-generation stems sums up approx. 650 ±210 g/m^2.

Harvesting reed area no. 14, Crişan, is situated at the north-west of Roşu-Puiu depression, framed at the north by Sulina branch and at the west by Crişan-Caraorman channel. Within Crişan area, the vegetation is represented by more than one categories (willow forests with reeds and reed mace and reeds (*Typha angustifolia* and *Phragmites australis*), reeds, sedges and willows, reeds on gleic soils (fluvial deposits), reeds on peat gleic soils, reeds on psamosoils, reeds on compact floating islets, reeds with *Salix cinerea* on compact floating islets, reeds on split up floating islets, reeds on floating islets with water pools), but only 4 categories of those mentioned have harvesting importance: reeds on compact floating islets, reeds on psamosoils, reeds on gleic soils (fluvial deposits), reeds on peat gleic soils. As it is an area which includes lakes, the dominant reeds are on compact floating islets - 35 % out of the harvesting area. Being given the fact that within the area there are important sand surfaces, the percentage of reeds on psamosoils is high (31%). The other reed types cover 19% - reeds on peat gleic soils and the rest of 15% - reeds on gleic soils. The total area of these harvesting reeds sums up 842 ha and the harvesting reed amount is 505.2 tones. The dominant reeds in the area have the density 140±10 green stems /m^2, and the average stem height of 190±35cm the base stem diameter is 8±2 mm and the total biomass of the last-generation stems sums up approx. 1,490 ± 175 g /m^2.

The average biomass of Danube Delta reed beds at the beginning of the '90^{th} (Chifu et al 1993) was 1.53 Kg/m^2, nowadays following the results of each reed complex area, the average biomass is 1.25 Kg/m^2.

New measurements show that it is a slight decline of the reed bed areas of an average of 0.25 % with a particularly high rate in the eastern fluvial part of the delta. An increase in reed area of 0.4 % was observed only in reed complexes with psamosoils and salinised organic soils, during the 2002-2010 periods. Such an average rate, even though it leads to a 50 % disappearance of the reed bed in a 250 year period. Most major changes observed were related to deep water lakes and floating reed beds.

At the edge of the lakes we observed decline but no re-colonization within the study period. Most edges of reed beds around those large lakes are sharp erosion edges rather than colonization margins. Size of the lakes is increasing by thinking of reed beds with formation of organic bottom. On the soil map deposits (Munteanu 1996; Munteanu & Curelariu 1996) bottom of central part of the pristine lakes consist of silt or sand deposit while margin of the lakes relatively new formed lakes (eg. Baclanesti) consist of organic deposits most probably thinned plaur. At a shorter time scale, our observations support the hypothesis that beside eutophication, colonisation of floating reed bed by other species (*Thelypteris palustris*, *Carex elata*, *Typha angustifolia*) contribute to a decrease in buoyancy and in time reed rhizomes will decompose, loose the floatability and finally sink together with above plants. Where the reed was recently harvest or burned reed density was higher and with a higher level of healthy floating rhizomes (Hanganu 1995 – 2002).

We observed that the thickest reed beds with the highest reed dominance and rhizome volumes had been burnt rather recently (burned stumps). Fire seems to favor reed at the expense of other species and particularly willows (*Salix cinerea*) and ferns, both species causing decrease in buoyancy (Nevel et al 1997). On the short time scale, fire does probably block the colonization by non reed species, favor buoyancy and strengthen floating reed beds. Reed harvesting, when it was done on ice and at a large scale, probably had similar effect. The use of fire as a management tool to block succession would probably decrease this decline. In any case, a monitoring of fires set by local inhabitants would be of prime importance.

Taking into consideration the exceptional conditions of the water level, field information have been corroborated with previous year's reference for closer-to-reality estimations.

This fact is necessary being given that many fields suffer from flooding with negative or positive influence upon vegetal species development depending on their preference for the hydrological factor (favoring the mezohigrophyle and hydrophyle species, disfavoring the mezoxerophyle and xerophyle species) and for the nutrient amount.

At the same time, flooding some field for long periods influences competitive effects between particular species such as the competition reed-bulrush or reed-reedmace.

Because of the large studied areas, tele-detection employment has been necessary to map the reeds. The data obtained by means of photo-interpretation have been verified during field trips. The mapping carried out so far reveal that the reed areas within D.D.B.R. sum up 220,000 ha, out of which 51,233.3 ha represent the potential harvesting areas.

Large surfaces of mono-dominant reed beds in Danube Delta are explained by management type as traditional burning and large scale harvested in the last 50 years. Nowadays because of diminished of the area burning and harvested the degeneration of the reed bed by scrub encroachment and litter accumulation is extended. Large area of reed beds in Danube Delta especially in the Matita-Merhei and Gorgova-Uzlina lake complexes, where the water circulation is adverse, are in process of die-back because of litter accumulation. It is known that organic matter accumulated in reed dominated wetlands and its decomposition is one of the causes of reed die-back because of fermentative toxic products and oxygen demand (Van der Putten 1995). Previous studies conducted in Danube Delta has shown that after the winter burning the reed productivity and quality are uniform without recording fluctuation as in the areas that are yearly harvested (Rudescu 1965). After the burning reed quality, density and productivity are improved the effects being more visible on areas were the reed is degenerated (Stoica 1972). On the non-managed areas peat willow (*Salix cinerea*) white willow (*Salix alba*) and indigo bush (*Amorpha fruticosa*) bushes are in extension. In the area where the reed was burned or harvested the water lake quality and fish yield are improved (Rudescu 1965).

Summer cutting of reed for cattle food is a traditional activity for local farmers in Danube Delta and by law is permitted to cut 2 tones of reed or reed mace per family. Some small area easy accessible alongside lakes and water courses are managed in this way and as a consequence of this practice reed grow densely and thin, increasing the diversity of plants and prevents degeneration of reed bed by scrub encroachment.

Early harvesting of the reed has a negative effect on the accumulation of sugars in the rhizomes (Stoica 1972). Rhizomes can continue to produce new shoots until October, but if new shoots are continuously cut during the summer sugar accumulation will be greatly reduced. This leads to a progressive elimination of the rhizome and the production of small stems similar in size and appearance. Grazing can cause damage in this way, but may be a useful tool for the creating of biodiversity in reed beds that are not harvested commercially.

Sustainable management of reed dominated wetlands requires the conservation of the components of the ecosystem and their characteristics as far as the present climatic and geomorphic conditions are kept. Spatial and temporal fluctuations are part of the characteristics of reed stands, particularly in the temperate zone. So, in order to decide if a management practice must be implemented in a reed dominated wetland, at local scale, it must be defined if the observed characteristics are part of their seasonal and inter-annual fluctuations or are part of a trend which indicates that a degradation process is taking place. The changes in the characteristics of a reed wetland may be artificially induced. Man-made disturbance is the most frequent cause of loss or expansion of common reed stands. The die-back process is responsible for loss of more than 50% of the common reed habitat in many places in north and central Europe (Ostendorp 1989). However, it has been a common fact also that expansion of the common reed stand in many south Europe wetlands took place mostly because of man regulation, mostly temporal homogenization, of water flow and level.

It may be a general trend of changes of the spatial distribution of habitats in a territory, including expansion or reduction of the common reed beds. *Phragmites australis* is a salt tolerant species which may grow in soils where the salt concentration of the interstitial water reaches 50 psu (Hellings & Gallagher 1992). The common reed beds become more homogeneous and plant growth may recover if exposure to brackish conditions is short (a few weeks) and flushing with freshwater proceeds later. Economically, that is why the most appreciated eco-type of reed is on slightly salinised psamosoils or salinised organic soils, which is very compact and thin comparing with the other. Naturally, it is a more sustainable strategy to let the habitat distribution of the territory to evolve under the climatic and geomorphic forces, not directly induced by anthropogenic activities, than try to maintain a constant spatial distribution of habitats. On the contrary, yearly burning of the same areas can be considered a non-sustainable practice on a 20 years management plan, because it contributes to green-house gas increase in the atmosphere (Brix et al 2001), and also can contribute to biodiversity reduction, in time. Another aspect of this practice management show, according to literature data, that in the spring period there were identified several bird species nesting on the ground. It appears in some cases that the burning process during the winter, when the soil is frozen can be an advantage in spring time for certain birds species that are usually nest on the ground or in shallow waters (Covaliov 2003-2007; Doroftei 2008-2010). However, reed beds surfaces design to be harvested in every reed complex can be rotated similar to the crop rotation for common land agriculture. For example, the reed surface designed to be burnt this winter will be the harvest area for the next year, and then it should be cast off for another year in biodiversity purpose.

Conclusions. Although the total reed area is mapped as 220,000 ha, the area planned to be harvested is 51,233.3 ha. Presently, the Danube Delta Biosphere Reserve is divided in 14 reed complexes and economically, contains 5 eco-types of harvesting reed. Due to their biometrical characteristics, from these 5 eco-types, the most wanted is the reed type that grows on salinised organic soils and psamosoils, which are mainly distributed in southern and western part of Danube Delta near to Black Sea shore. According to the new measurements a slightly decrease of average biomass with 0.25% is registered, especially in the eastern fluvial part of the wetland. Management practices such as burning and cutting can be favorable for reed development in short periods, two or three years. As for the reed on compact floating islet the buoyancy is increasing due to reed dominance and rhizome volume in opposition to other species. For sustainability, economic and biodiversity purpose, it appears that is better to apply the system of crop rotation used on agricultural fields.

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