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SOIL AND WATER MANAGEMENT FOR COMBATING FLOODS AT THE FIELD OF MALIQ

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Abstract

This report deals with some of the main problems that are present at the peaty field of Maliq about 5300 ha, from which 2050 ha are Histosols and the rest Luviosols and Fluviosols. Maximal thickness of the peaty depositions is currently about 7,5 m compared to 11,5 m before the drainage of the bog, about 60 years ago. The compound of the organic matter at the horizon H is about 40%, compared to 1,8 – 1,9% at the average of the burned horizon and 16% at the mixed horizon and at the covered soil. The reduction of the peaty level has differed in years. At the period 1947 -1978 according to the zones it goes about 0-0,5 m to 3,5-3,8m, at the period 1978 -1996 from 0-0,3 to 1,3 -1,6 m and actually in total it is about 1,5-3 m and to specific zones even 4,5-5 m. During the years 1962 - 1974 the average reduction has been 13,3 cm per year, and from the year 1974 until 2006 by 3,7 cm per year. The immediate reduction of the level from 90-100 cm occurred as a result of the incineration of the peat at about 1600 ha. As the result of this situation, but also from other factors, the folds at this zone are continuous, reaching till 3500 ha per year at the beginning of the year 2010 from which at more than 500 ha is impossible the agricultural activity as the result of the continuous activity of the water. The present situation makes imperative and urgent the improvement of the drainage situation through the construction of a hidrovor and other additional works at the constructions and the drainage network.

Keywords: peaty soil, incineration, mineralization, level reduction, flood.

1. INTRODUCTION

The field of Maliq has a surface about 5300 ha that is stretched 10 km at the north of Korça city (figure 1). This is one of the most fertile fields of Albania. Before the year 1948 this field has been a bog (lake) in which was discharged in natural way the rivers of Devoll and Dunavec and the surrounding brooks. The water level during winter with maximal rainfalls reached the absolute quote 820 m above the sea level; and during drought period the water level was reduced to the quote 816,4 m, creating so far a zone with permanent water about 2000 ha. The lowest quote of the lake floor and actually of the entire field of Maliq was 814,6 m. The highest depth of the lake was about 2,0 m. This situation has impacted about 7500 ha of land surface, and especially 5500 ha had no guaranty for any agricultural cultivation (PMBU, 2006).

The earliest works to capture the land from the bog started at the period 1930 – 1933. These works were intensified at 3 km of Devoll river bottom and were constructed also some embankments. But these works did not generate the expected results. The full melioration of the Maliq field was done in three future steps. During the years 1946-1953 were developed the works of the Phase I. The works consisted to the construction of the Maliq Regulator with an absolute quota of the river floor of 812,4 m. Was constructed the embankment at the rivers Devoll and Dunavec and was dug a network of drainage channels at the entire surface. The lake of Maliq was conserved in a surface of 1000 ha. Very soon by the passing of the years, the intensity of the reduction of the peat level was big and the water surface of the Maliq lake from 1000 ha went to 1500 ha and more, deteriorating the situation of the neighbouring fields.

Figure 1. Location of peaty soil of Maliq

At the phase II of the melioration of Maliq, during the years 1960-1964, was done the complete drainage of the Maliq bog.
During this period was removed from the map the lake of Maliq, as the result of the deepening and extension of the rivers Devoll and Dunavec.
Was constructed the new Regulator of Maliq with a floor quote 808.6 m, or 3.8 m lower than the previous Regulator. Was constructed the secondary channels network in a distance of 500-800 m from each other and was foreseen the construction of the tertiary irrigation channels in a distance of each 100 m at the peaty zone and each 200 m at the non-peaty zone.
According the project was accepted that for the rainfalls with probability 20% (once in 5 years) to flood a surface of 870 ha for 16 hours. By the conclusion of these works the all the agricultural lands gave agricultural efficiency.
The change of the conditions caused by the natural reduction of the peaty, lead to complementary melioration works during the period 1982-1990, which are known as the phase III of the melioration of the field, important to mention the construction of the Regulator with floor quote 806,6 m, or 2 m lower than the one constructed in 1960.
Even after the years '90 are done some other partial interference, which did not solve the melioration issue of the zone.
Despite of the different works, the non implementation of the project did not solve definitively the management of the water and soil.
The peaty zone of 5300 ha was put in agricultural utilization after the drainage of the Maliq bog. From this surface about 2400 ha are uncovered peaty soil (Histosol), the rest about 2900 ha are peaty covered with clay lay in depth 0.5-2.0 m (Luvisol) and alluvial (Fluvisol) (PMBU, 2006). The peaty massive is distinguished especially for the high efficiency in grain, potatoes, sugar-beet, most highest in the country.
After the years '90 as the result of the decrease of the diligence for the soil and water management, intensive incineration of the peat, cutting of forests, insufficiency of the maintenance works, almost full un-functioning of the secondary and tertiary drainage channels, change of the land ownership, etc., the peaty zone is damaged a lot.
The continuous floods during the intensive rainfalls period are very disturbing, at almost the entire surface of 5300 ha. During the winter months, by the end of 2009 and during the first months of 2010 the flooded surface reached its maximum, about 3500 ha.
The duration of the flood at the lowest zones of the field was longer than 6 months. This situation caused agricultural and environmental problems and hindered the life of the inhabitants of this zone.
To evaluate the situation and to analyze the problems are done the studies like "the improvement of the peaty soil of Korça field" (Plaku et al, 1997a); "Improvement of the drainage at peaty zone of Maliq field with a surface of 5300ha" (PMBU, 2006).
Both studies suggested as the foundation of the sustainable management of the water and peat the construction of a hidrovor. Independently from the results, was expected that during the last quarter of the year 2010 should start the deepening of a part of the Devoll river bed, as partial and temporary solution.

2. MATERIAL AND METHOD

Climatic conditions

The field of Maliq takes part at the Mediterranean pre-mounting south climatic zone. The yearly average temperature fluctuates between 9,5 – 10,5^{o}C (July 20^{o}C, January 0,5^{o}C). The minimal temperatures are observed every year from -10 to -12^{o}C and in rare cases up to -25^{o}C, minimal absolute -26,8^{o}C (the lowest temperature registered in Albania). Annual rainfalls in quantity fluctuate from 650 to 750 mm and are concentrated mainly during the period October – February.
During summer time precipitations fall about 10-12% of them. Maximal rainfalls for 24 hours with 40 % probability are 106 mm.
The snow creates a layer, depending on the case, since November until March (Ash, 1988).

Peaty incineration

The massive incineration of the peat at the Maliq field appeared during the period 1991- 1996. Before the year 1990 such an occurrence was not known, as the result of the diligence and the immediate measures to interrupt the incineration as soon as it is realized.
The peaty incineration (figure 2) is caused by purposely burn of the residuals of the plants after the harvest from people, forced also by the fact that after the burning process the cultivate cultivation of the potassium plants like potatoes and sugar-beet gives high efficiency; set of fires from the shepherds; natural self-inflammation of the peat as the result of the high temperatures until 60÷80ºC by the activity of aerobic microorganisms.

Figure 2. Peaty incineration, October 2008

The burned surface is about 1600 ha, and a part of it, about 300 - 350 ha is burned twice (Damo et al, 1999a, 2009). The incineration although with low intensity continues still to separate zones (figure 2) and is very difficult to clarify the burned surface two or three times. The average thickness of the burned peat is 52 cm and the remaining matter after the burning is about 11 cm (y = 0,275 x -3,91). At each incineration the peaty level is reduced about 40 cm (Plaku et al, 1997a, 1997d).

The incineration one time of the peat reduces the level in equivalent with natural reduction of about 15 years, the incineration two times is equal to the natural mineralization of over 30 years.

The peaty incineration, except of the level reduction, caused other big changes. It is almost totally avoided the natural process of their paedogenesis, the profile construction has obvious changes in colour, in horizons` depth, physic and chemical characteristics etc. (figure 3).

The incineration of the peat has increased the volumetric and specific weight, has decreased the porosity of the air, water capillary capacity and hydroscopic humidity etc. (table 1, 2).

Horizon H is totally damaged, bringing to the surface in many cases, non-mineralized peats (T) (Plaku et al, 1997a). Horizon H at Histosol has average depth 25-40 cm. Normally this horizon should almost be uniform at the whole surface with uncovered peaty horizon, but the incineration has its own impact. The minimal depth is observed to the lands where the burned layer is mixed with the non-burned peat. At the lands with covered peaty horizon the thickness of the horizon Ap is more sustainable, it fluctuates from 30-37 cm.

The biggest thickness belongs to the most evolved parcels, those that have small changes from zone lands (Damo et at, 1999a).

Depending on the time after the incineration and on other interferences (cultivation, erosion, and flood) can change the profile of burned lands and the characteristics of the horizons.

Figure 3. The remaining material after the covered peat incineration, from the mineralized peat as the result of the erosion process.

Even the chemical characteristics have occurred big changes (Plaku et al, 1997d; PMBU, 2006). The average compound of the organic matter at the horizon H both mineralized and burned has had big changes. To the first is about 40%, to the second is about 0.52 - 2.90%, or in average 1.9%. The minimal compound 0,52 - 0,6% is immediately noticed after the incineration and the maximum is 2,6-2,9% a certain time after the incineration. The data show that during the incineration of the workable horizon the compound of organic matter is diminished in drastic way. At the mixed horizon and to the covered lands the compound is about 16%, and to the horizon T to uncovered peaty land is about 65% and to the covered ones goes down to about 50% as the result of the slit depositions.

Table 1. The change of some of the physic characteristics

Land type	Volumetric weight g/cm^3	Specific weight g/cm^3	General Porosity %	Air Porosity %	Capillary porosity %
Mineralized H Horizon	0.41	2.102	80.0	24.7	53.3
Material after incineration	0.55	2.969	81.5	18.4	63.1
Non-mineralized Horizon T	0.18	1.849	90.2	17.3	72.9

Table 2. Some water characteristics of peaty soil

Soil type	Capillary water capacity		Full water capacity		Hydroscopic humidity%
	% dried soil	% wet soil	% dried soil	% wet soil	
Mineralized Horizon H,	135.4	55.8	165.0	67.8	11.0
Material after incineration	114.8	53.4	148.3	62.2	3.6
Non-mineral Horizon T	405.5	76.1	476.0	82.6	15.5

The average grade of organic matter mineralization at the horizon H is 40%, and at the burned lands is 97-98%. This shows that the mineralized organic matter from one burning, taking into consideration the average coefficient of the mineralization about 1%, at normal conditions would have been mineralized during a period over 50 years. At the lower horizon T the mineralization is small; in specific cases it may reach 10 – 11%.
The non uniform incineration of the land within a parcel has damaged the uniformity of the fertility. This is obvious not only from the change to the wide range of the compound of organic matter at the workable horizon (2-3 % until 40 %), but also from the compound of the total nitrogen, which value to the mineralized horizon H is in average about 1,7%, to the remaining material right after the incineration 0,05 – 0,006%; to burned horizon 0,2 - 0,23% and to the mixed and covered one 1,1-1,2%. So, the incineration reduces extremely the nitrogen compound and as the result the fertility of burned peaty soil, which after several years can be regained from the potential of the T layer that has in average 2,54% N.
The very bad management of the peaty surfaces, allowing the massive peaty incineration brought important impact to peaty lands and their fertility, which have their own negative effects to the plants cultivation and production.

3. RESULTS AND DISCUSSIONS

Reduction of peaty level

Peaty soil compared to other mineral soils, because of its completely different conditions in which the peaty material is located, change thoroughly their characteristics and the construction profile of the soil (Driessen, 1991). Their particularity stands to the process of peat mineralization that leads to the gradual reduction of the level. The cultivation of Maliq land stimulate the decomposition of the organic matter, its intensity depends on other factors like humidity, temperature, deposit of organic compound, microbial activity, decomposition period etc. According Boul, et al (1989), this process constitutes the maturation of peaty soil, and it is developed in different ways depending on the above mentioned factors. Right after the melioration, by the initiation of the microbiologic activity or by the initiation of the maturation, started also the process of peat reduction as the result of the mineralization of the organic matter according Couwenberg (2009), the drainage of peaty soil manages the peat oxidation that results with big loss at the atmosphere of carbon and nitrogen. The preservation and management of the peaty soil can contribute to the reduction of climacteric changes.
To minimize the process of peat mineralization, to the peaty massive until the year 1990, except the regular irrigations, during summer is maintained high the level of the underground water level through the closure of the main channels. After the years 1990, the change of the land ownership, was accompanied with the deficiency of water sources for irrigation, the complete cut of protective forestry strip, non management of the drainage channels which impacted the increment of the intensity of natural mineralization of the peat. During this period was observed the phenomena of massive incineration of the peat, which leaded to the immediate reduction of the peaty level. The peaty reduction fluctuated during the years. In the years 1962 until 1974 to the main zone the average reduction has been 13,3 cm per year, and from the year 1974 until 2006 by 3,7 cm per year (PMBU, 2006). The reduction of peaty level during the period 1947-1978 changes to the zones and moves from 0-0,5 m to a maximum of 3,5-3,8 m (Plaku et al, 1997a). Nowadays the average reduction of the peat is 1,5-3 m and in specific zones until 4,5-5 m (figure 4).

Figure 4. Diss-level of the surface created during the year's causes massive floods, March 2010

According Plaku et al (1997b) to the passively burned blocks the reduction of the peaty surface in the year 1996 compared to the year 1978 reaches until 1,5 -1,6 m. the natural reduction of the peaty level during this period was about 50-60 cm. The difference about 1 m is the result of the massive peaty incineration mainly during the years 1992-1996, in the peak of this phenomenon.
The data of the figure 5, that shows the reduction of the peaty level to one of the typical zones, indicates clearly the reduction of peaty level during the

period 1948 - 2006. The maximal reduction about 3.7 m is observed to the picket No. 5. The reduction is also low even to the pickets 2÷4 and 6÷7, respectively about 3.56 to 3.69 m and 3.42 to 3.59 cm. To the extremity pickets the reduction has been smaller, 2. 24 m and 2.6 m respectively to the ones, with number No. 0 and nr. 9.

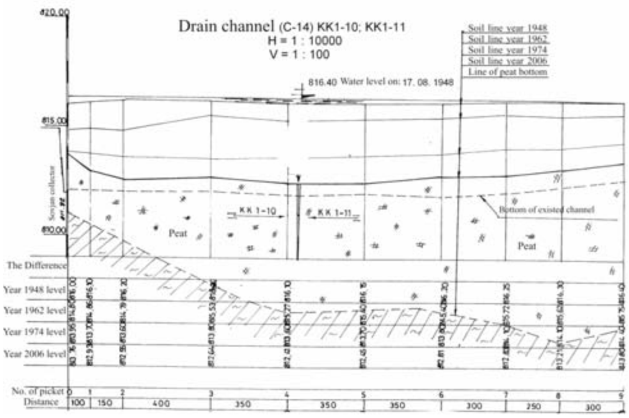

Figure 5. Peat reduction during the period 1948-2006

The peaty incineration process is not developed in uniformity in the three dimensions of the space and as a result is created diss-levels to the surface (50 - 60 cm even until 100 – 150 cm). this fact is verified easily from the data of the figure 5, where between the maximal (picket No. 5) reduction of the level and minimal (picket No. 0) is a difference about 1.46 m. the difference of the surface level between the two extremity points of the chart in the year 1948 has been 40 cm, and in the year 2006 1.4 m. It is interesting the fact that the lowest quote, about 812.40 m are observed to the middle of the parcel length and the most highest about 813.80 m at its extremities. Such an accident of the surface created problems to the implementation of the agro technical measures, non –uniform increment and development of the plants and specially the land flood.

As the result of the natural mineralization of the organic matter and peat incineration its average thickness is from 3 - 6 m and in specific zones 11.5 m after the irrigation of the bog, today it is in average 0,4 – 2,6 m to the Histosol lands and 0.5-2.0 m to the Luvisol and Flufisol lands. The maximal thickness of peaty deposits reached at about 7,5 m (PMBU, 2006).

The flood of the peaty massive

Although that after the year 1992 are done several investments for the partial cleaning of the river Devoll, main collector, some of the secondary drainage channels etc., the issue of the drainage of the Maliq field is not even improved, but worsened further. The big reduction of the peaty level, the over load of the river Devoll with 1,0 – 1,5 m to the lower part of the Regulator of Maliq and also to the upper part, the fill of the main collector, almost total un-of the secondary channels the missing of the tertiary drainage channels makes that during the winter time the underground water is mixed with superficial water and the zone suffers continuous floods. The flooded surface fluctuates depending on rainfalls intensity, from 500-600 ha to about 3500 ha, as happened in the beginning of the year 2010 (fig. 5). The flood period lasted from 8-9 months (2009 – 2010). The water thickness to the flood surface fluctuates from 0 until 80-100 cm, maximum value to 3 m (February 2010). As the result of this situation a surface over 500 ha land is continuously under the water impact and is impossible the agricultural activity. Over this surface started the re- bog process, clearly explained by the development of the typical water land plants.

Flood management

The water presence over the agricultural surface for a period longer than 5 days is evaluated with the degree badly (Shepherd et al, 2008a, 2008b) to the peaty soil of Maliq the period of water presence continues per months, therefore the primary and immediate problem is the management of the floods.

By the beginning of the year 2010 the Agriculture Ministry offered the immediate and electoral solution the deepening of the Devoll river bottom, in a length of several kilometers, down the Maliq Regulator until the location called Tyrbja e Goçës. This can be a temporary solution and by the passing of the years, as the result of the continuation of the reduction of the peaty level the river Devoll should be deepened. We think that this found solution of commence at the end of the year 2010 can not be effective, also other works done during the past decade.

The complete and definitive solution of the drainage problem for 3500 ha to the lowest part of the zone should be done by mechanical erection, by the construction of a hidrovor, accompanied by additional works to the rivers, to the constructions and to the drainage network (Plaku et al, 1996a; PMBU, 2006).

This solution has a construction cost of 6,5 million €. According to our calculations, only the thermal energy of the burned peaty massive during the 20 last years is equivalent to 250 million €. The average economical damage (the missing incomes from the non production and its sale without the production expenses cost) during one agricultural

year caused from the non cultivation of the surface where the agricultural activity is impossible is about 2.1 million €.
Except of the two proposed solutions for the construction of a hidrovor, a third option should be taken into consideration, similar to the first phases of the field melioration, but with the presence of the hidrovor, leaving a certain surface covered with water under controlled regime during the entire year. This option can affect the improvement of the micro climate of the zone and the increment of the biodiversity that had changed thoroughly after the drainage of the bog.

4. CONCLUSIONS

To the peaty soil of Maliq field after the years 1990 started powerfully different degradation processes as the result of the inefficiency of their management measures, also from the often and totally wrong interferences of the human factor. The surface of the burned peat is over 1600 ha, a part of it is also two and three times burned. From the first incineration of the peat the reduced peaty level is equal to the natural reduction of about 15 years. The phenomena of the massive incineration of the peat together with the natural mineralization of the organic matter caused sensitive reduction of the Maliq peaty massive surface. The average reduction of the land surface is 1,5-3 m and to specific zones up to 4,5-5 m. The big reduction of peaty level and the refill of the drainage channel network and the river Devoll is the cause of the continuous floods that reached till 3500 ha during many months. In over than 500 ha land is not possible to cultivate, with a relatively high speed growth tendency. To solve the drainage problem of the field is necessary the construction of the hidrovor. The delay for its construction more and more increases the agriculture, economical and environmental consequences of the zone.

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