Professional paper

DAMAGE ASSESSMENT IN AGRICULTURE – FLOOD DAMAGES IN PERENNIAL CROPS

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ABSTRACT
Contributing to the already existing vulnerability and risks for the agricultural producers, natural disasters influence the development of agricultural production and in most instances with a negative connotation. Agricultural production is greatly reliant on weather conditions, and is often adversely affected by disasters related to weather and climate circumstances. In August 2016, North Macedonia and especially the region around the capital city of Skopje was heavily hit by floods, causing considerable damage to the agricultural production in this region. This natural disaster is expected to have a prolonged impact and assessing the damage for the perennial crops is important for the farmers, but would also contribute in the evidence based research on the topic. The results presented in this paper are based actual data, collected immediately after the flood. The analysis includes the reported damages in crop production, their structure, area affected, etc. The damage estimations are based on standard valuation methods published in the national Official Gazette. The data set contains information that provide damage assessment, but also gives grounds for compensation of farmers who were most affected. There is an urgent need to mitigate the effects of natural disasters in the agricultural sector, as well as highlight the need of permanent prevention and insurance practices in the sector.

Key words: damage, evidence based, flood, natural disasters, Skopje region.

INTRODUCTION
Contributing to the already existing vulnerability and risks for agricultural producers, natural disasters influence the development of the agricultural production and in most instances this influence has a negative connotation. A vast number of agricultural households are faced each year by disasters and crises. This is especially a case with the small family farms, which subsist on the production, marketing and consumption of crops or livestock products. Disasters can develop slowly over time, as in the case of droughts, or can occur in isolation, in triggered consecutiveness or in simultaneous combination, with mutually magnifying effects. Such emergencies pose serious challenges to agricultural production and food security (FAO, 2018).

A natural disaster represents a serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the capacity of the affected society to cope using only its own resources (FAO, 2018). Anderson (1995) defines the natural disasters as temporary events triggered by natural hazards that overwhelm local response capacity and seriously affect the social and economic development of a region. Understanding the natural disasters is very important since their nature, frequency, intensity, and duration determine the impacts on different entities, and especially the small farmers. In this context, different threats and crises are considered as natural disasters, such as: geophysical (earthquakes, tsunamis and mass movements); droughts; floods; storms (including tropical, extra-tropical and convective); wildfires; extreme temperatures; and biological disasters

(epidemics, infestations) (FAO, 2018). Natural disasters have hit every country in the world with growing frequency and intensity, whereas their impact on livelihoods and economies at both local and national level is also increasing significantly. According FAO (2018) the economic loss associated with such disasters on a global level, averages around 300 billion USD every year, and this study also finds out that in the developing countries, an average of 260 natural disasters occurred per year between 2005 and 2016, taking the lives of 54 thousand on average each year, affecting over 97 million others and costing an average of 27 billion USD in economic loss annually.

So, these findings indicate the huge impacts of natural disasters over the whole economy in a country, with agriculture being one of the most affected sectors, since it is directly under the influence of the weather and climate conditions. Agriculture tends to be one of the main economic activities in developing countries, contributing on average between 10 and 20 percent of national GDP in lower-middle-income countries and over 30 percent in low-income countries. Moreover, it plays a key role in balancing the social, economic and environmental aspects of development while providing durable employment, sufficient income and decent living and working conditions for the farmers and rural populations. On the other side, agricultural production is greatly reliant on weather conditions, and is often negatively affected by natural hazards and disasters related to this weather and climate circumstances, making this sector to be particularly vulnerable.

One of the natural disasters that usually affect the agriculture are floods. The flooding impacts over the agricultural production can be analyzed from two perspectives, i.e. direct impacts that arise from the direct physical damage on crops, animals and trees caused by the extreme hydro-meteorological event, and indirect impacts which refer to loss of potential production due to disturbed flow of goods and services, lost production capacities, and increased costs of production (Sivakumar & Hansen, 2007). Additionally, flood impacts can also be classified as tangible or intangible. Where tangible impacts are those that can be easily measured in monetary terms, while the intangible impacts are often difficult to measure in monetary terms (*ibid*).

In this context, the loss of perennial crops has long-term consequences on the ability to generate income since floods make the land to be unsuitable for agricultural production until waters withdraw, but also leads to loss of soil nutrients, permanent damage to perennial crops, greater susceptibility to diseases and insects, interruptions to farm operations, may affect the buildings and machinery, etc. The economic consequences of such disasters are also very important, and therefore there is a strong need for their appraisal when such disasters happen.

Established appraisal methods exist for determining the value of growing crops. Most of these methods are utilized in valuing permanent plantings such as orchards and vineyards. Permanent plantings present a distinctive dimension to land appraisal because of their plant life characteristics (Salassi *et al*., 2000). In addition to the normal ground preparation, planting, and fertilizing, these specialized properties require a startup period of several years before a cash flow is realized. The orchard or vineyard has a period of peak production, followed by a period of declining production, unless the old trees are removed and replaced as necessary. These specialized properties are typically found in one of three stages of development: (1) development or immaturity; (2) sustained maturity; or (3) decline (Milanov & Martinovska Stojcheska, 2009). Each of these stages may require a different appraisal method or emphasis.

In August 2016, North Macedonia and especially the region around the capital city of Skopje was hit by floods, causing considerable damage to the agricultural production in this region. According to the reported damages by the agricultural households, an area of more than one thousand hectares from 11 cadaster municipalities was affected. Most affected were cash crops, perennial crops, and to some extent crops cultivated under plastic tunnels. Most of the affected farmers had not insured their agricultural production.

Considering the above mentioned, the aim of the paper is an assessment and valuation of the damages for the perennial crops in the affected region by floods as important factor for the affected farmers. Thus, this study should also contribute to the evidence based research on the topic.

MATERIALS AND METHOD

Different sources of data were used in this study. Primary data were obtained directly from the farmers who have reported damages caused by the floods in the region. In this way, a survey of 373 agricultural households was conducted, capturing a total area of damaged perennial crops of 84 hectares. The survey was based on structured questionnaire collecting data about the type of production, technology of production, crop varieties, yields, as well as income and costs data per farm. The primary data were supplemented with secondary data, mostly obtained from the State Statistical Office and used for time series and comparative analysis of the yields per type of crop production. Beside this, price data were obtained from the Agricultural Market Information System, for the period 2013-2015.

Standard valuation methods for agricultural assets were applied. Here, it is very important to determine the type of value one should valuate, *i.e.* whether it is the market value, as the most probable price of a property on the open market, the net income value, as the present value of future yearly net income, and mostly used for investment decisions or market simulation, and/or the cost value, as replacement costs minus depreciation, being mostly used for insurance compensation and market simulation (Milanov & Martinovska Stojcheska, 2009). Additionally, when appraising the agricultural production and agricultural land different factors should be considered, such as: size in terms of hectares, locations, productivity and soil quality, access to water, transport and so on. All these factors were also considered when applying the valuation methods on the affected farms. The application of certain valuation method mostly depends of the stage the perennial crop is in, so for the matured or crops at sustained stage of production, the Income Capitalization Approach was applied (equation 1), while for the immature crops the Cost Approach was utilized (equation 2) (Milanov & Martinovska Stojcheska, 2009). Both methods are officially accepted for valuations in agriculture, and published in the Official Gazette (2011).

$$P_v = Rn\,\frac{r^n-1}{r^n(r-1)} \text{ or } P_v = Rn\,\frac{r^n-1}{r^n(r-1)} + \frac{V^n}{r^n} \quad (1)$$

whereas, *Pv* denotes income capitalized value, *Rn* income, *r* interest rate, *n* years of cultivating, and *V* the residual value.

$$Nv = a_0 r^{n-1} + a_1 r^{n-2} + a_2 r^{n-3} + \cdots + a_n \quad (2)$$

whereas, *Nv* represents cost value, a_n investment and input costs.

RESULTS AND DISCUSSION

North Macedonia, especially Skopje region, was strongly affected by flood in 2016. This natural disaster has occurred due to strong intensity and long period of rains in that region. The flood caused huge infrastructural damages, but also very big damages in the agricultural production in that region. Most affected was the crop production, especially the production of spring annual crops, orchards and vineyards. Similar disasters happened in 2015 in several regions in the country (Pelagonia, Strumica, Tetovo, Kocani and Skopje), also caused by intensive and heavy rain periods (Mitkova *et al.*, 2016).

Beside the direct negative impact of the flood over the agricultural production in the region of Skopje, such natural disaster could have several indirect long term negative effects, mostly

related to the soil contamination, decreasing of the soil productivity, as well as occurrence of different microorganisms which further affect the production of safety food.

According to the reported damages by the farmers, a total of 2,056 agricultural households in Skopje region have been affected by the flood, cultivating in total 1,093 hectares (Table 1). Most of them (1,220) produced different annual crops, while 373 farmers cultivated fruits and grapes on a total area of 84 hectares. The average affected area per farmer was 0.53 hectares, while analyzed at the level of perennial crops producers, the average affected area per farmer was 0.22 hectares.

Table 1. Farmers affected by the floods, 2016

Crops	**No of farmers**	**Area affected by flood (ha)**	**Average area per farmer (ha)**
Annual crops	1,220	962	0.79
Perennial crops	373	84	0.22
Greenhouses	463	47	0.10
Total	2,056	1,093	0.53

Additionally, most of the affected agricultural production was the production of annual crops (59%), followed by the agricultural production in green houses and plastic tunnels (23%) (Figure 1). The production of perennial crops captured 18% of the total affected agricultural production in this region.

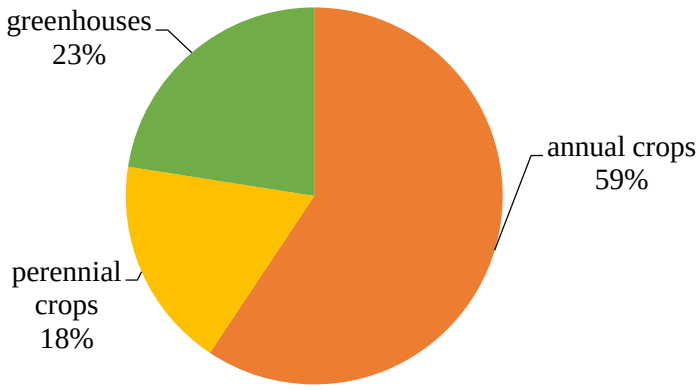

Figure 1. Affected agricultural production by the floods, 2016

Following the reported damages by the farmers it can be noticed that the storm was strongest in the area of villages Cresevo, Bulacani, Brnjarci and Aracinovo, where 373 producers of perennial crops were directly affected. These number of farmers have cultivated in total 820 land plots, on a total area of 84 hectares (Table 2).

Table 2. Total damage at the level of perennial crops

Number of farmers	373
Number of land plots	820
Total damaged area (ha)	84
Number of trees (fruit and grape)	223,562

If analyzing the structure of the perennial crops (Table 3), we can see that most damaged is fruit production with a total area of around 53 hectares, but on the other side, with relatively small number of trees per hectare (611) due to the low density of planted fruit trees (often with

inter crops between rows). The production of grapes covered 31 hectare of the total affected area and 6,118 trees per hectare.

Regarding the determination of the value of the damaged area under perennial crops, already established appraisal methods exist, and most of these methods are utilized in valuing permanent plantings such as orchards and vineyards (Salassi *et al*., 2000). However, when appraising the value for permanent plantings, their plant characteristics should be considered, i.e. in addition to the normal ground preparation, planting, and fertilizing, these specialized properties require a startup investment period of several years before a cash flow is realized. The orchard or vineyard has a period of peak production, followed by a period of declining production, unless the old trees are removed and replaced as necessary. These specialized properties are typically found in one of three stages of development: (1) development or immaturity; (2) sustained maturity; or (3) decline (Milanov & Martinovska Stojcheska, 2002). Each of these stages requires a different appraisal method or emphasis.

Two valuation procedures, the cost approach and the income capitalization approach, are used in this analysis to value the damaged perennial crops, and both approaches explicitly incorporate the impact of variety, expected yields and production costs into the appraisal process. In this context, the total appraised value for the perennial crops determined with this study is 487,362 euros, out of which highest value of the damaged crops was appraised for the fruit production (Table 3). Salassi *et al.* (2000) used the same approach when estimated the value of the sugarcane production in Lousiana and found out that the cost approach includes the expenses related to the improvements made by the sugarcane producer, where the fundamental assumption when using the cost approach to value sugarcane involves the allocation of planting costs to each successive sugarcane crop (plantcane, first stubble, second stubble, etc.). The authors also used the income capitalization approach when the sugarcane crop has reached a mature or sustained stage of production, and can be used at any point in time. Similar method and application was used by Sredojevic (1998), in valuating perennial crops in Serbia.

Table 3. Valuations per type of affected perennial crops

Type of crop	Area (ha)	Number of trees	Trees per ha	Appraised value (EUR)
Fruits	52.78	32,236	611	371,093
Grapes	31.04	189,942	6,118	111,909
Forest	0.42	1,384	3,287	4,360
Total	84.25	223,562	10,016	487,362

CONCLUSIONS

In last few years the climate change caused natural disasters, as floods, hails, spring frosts, which affected mostly the agricultural production. Therefore, the need for obtaining good quality data of the affected agricultural productions as well as the estimation of the value of the damages is significantly increasing in recent periods. Thus, this research is expected to contribute in the literature for valuations in the agriculture, focusing on the perennial crops damage assessment caused by different reasons. The production of perennial crops includes a longer crop cycle, so therefore the specific production characteristics should be considered when deciding which valuation method should be applied. Three general valuation procedures exist for valuing specialized agricultural properties such as perennial crops: (i) the sales comparison approach; (ii) the cost approach; and (iii) the income capitalization approach. The most appropriate valuation method to use in a given situation will depend upon several factors, the most important of which include the purpose and use of the appraisal, the stage of development of the plant life, and the crop characteristics. Considering that North Macedonia

was affected by strong storm in 2016, as well as considering the agricultural production characteristics, this study utilized two valuation techniques, i.e. cost approach and income capitalization approach for determining the value of the orchards, vineyards and the forests in the affected region of Skopje. This research also confirms that both valuation procedures should be utilized in order to provide information on the extent of a producer's loss. This is so since the cost approach provides a measure of the monetary investment in the production of the crop, while the income capitalization approach provides a measure of a producer's foregone future income. Based on that, highest damages are evidenced for the fruit producers, followed by the producers of grapes. In addition, more than 90% of the affected farmers do not insure their agricultural production, indicating that there is still a strong need for improvement of their knowledge on insurance in agriculture, but prevention should also be considered as an effective tool in anticipating reoccurring weather and climate changes events.

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