Annex D to "SUBMERGED: Study of the Destruction of the Kakhovka Dam and its Impacts on Ecosystems, Agrarians, Other Civilians, and International Justice"

Calculation of approximate losses resulting from the flooding of crop fields after the breach of the Kakhovka Dam

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The total area of crop inundation and related losses were determined based on data from a survey of crop loss areas in the Snihurivka community. This was a local survey extrapolated to the entire inundation area, considering the existing villages and crop types.[1] For the purposes of our calculation, we presumed that all the plowed crops within the flooded area were destroyed and can be calculated as losses.

Initial data

Flooded fields in Snihurivka territorial community [2]

Table 1 Survey of croplands flooded at the Snihurivka territorial community after the Kakhovka Dam Breach

Location	Spring barley, he	Sunflower, he	Alfalfa, he	Vegetables, he	Uncultivated lands, he	Misc., he
Pavlivka eldership district	76.00	0.00	0.00	4.0	29.82	0.00
Vasylivka eldership district	4.00	188.0	0.00	0.00	87.47	2.00 (peach orchardry)
Kobzartsi eldership district	21.18	115.96	5.58	0.00	0.00	0.00
Novovasylivka eldership district	0.00	0.00	0.00	0.00	0.00	1.49 (winter crops)
Afanasiivka eldership district	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	101.18	303.96	5.58	4.00	167.29	3.49
TOTAL LANDS	585.50					
TOTAL FOR CALCULATION[3]	416.21					

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[1] This is a conservative calculation based on the limited amount of data, which shows only a general idea of losses incurred as a result of flooding. The actual losses might exceed our calculations.

[2] This data was obtained from local authorities during one of the PEJ/TH joint field missions to Mykolaiv oblast.

[3] For the purposes of our calculation we have disregarded uncultivated lands and peach orchardry resulting in 416,21 he arable lands exposed to the flooding in Snihurivka terriotorial community.

This survey shows that about 280 he crop area was flooded in the Vasylivka eldership district. Matching remote sensing analysis of the flooded area with a google earth map of fields, we have confirmed that this number is accurate.
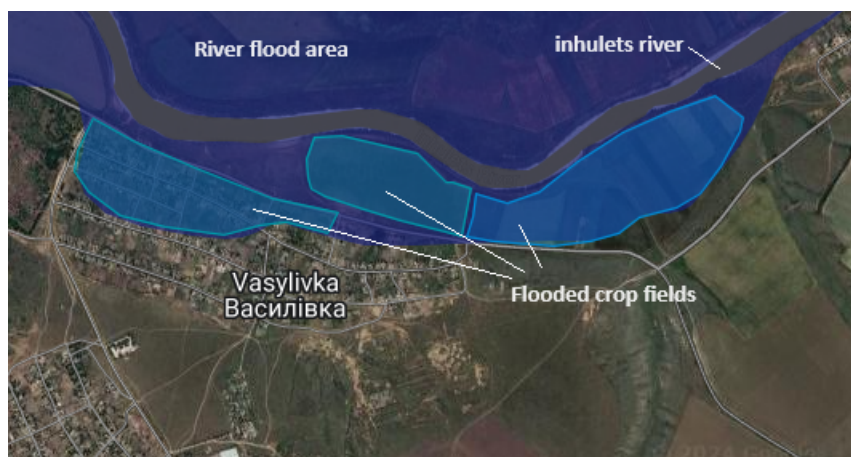
Yield

The total tonnage of agricultural crops was determined based on the average 5-year yield history for the region of interest.[4]

Crop type	Yield (MT/Ha)
Sunflower	2
Spring barley	3.1

Selling prices

The total loss amount in dollars was determined based on the latest (2021 annual) official selling prices of agricultural products by agricultural enterprises. These prices are also used by the Food and Agriculture Organization of the United Nations and can be found on their portal.[5]

| Crop type	Price (USD/MT)
Sunflower	610.4
Spring barley	214.9

Proportion of the losses at Snihurivka territorial community

We have manually observed the flooded area as well as considered existing villages and crop types both within the Snihurivka territorial community and the flooded area

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[4] *Площі, валові збори та урожайність сільськогосподарських культур за їх видами та по регіонах. Архів.* Держстат України, URL.

[5] *FAOSTAT Producer Prices*. Food and Agriculture Organisation of the United Nations. URL.

overall. As a result, we have concluded that crops flooded at Snihurivka territorial community represent approximately 8.3 % (0,083) of the total area of flooded crops.
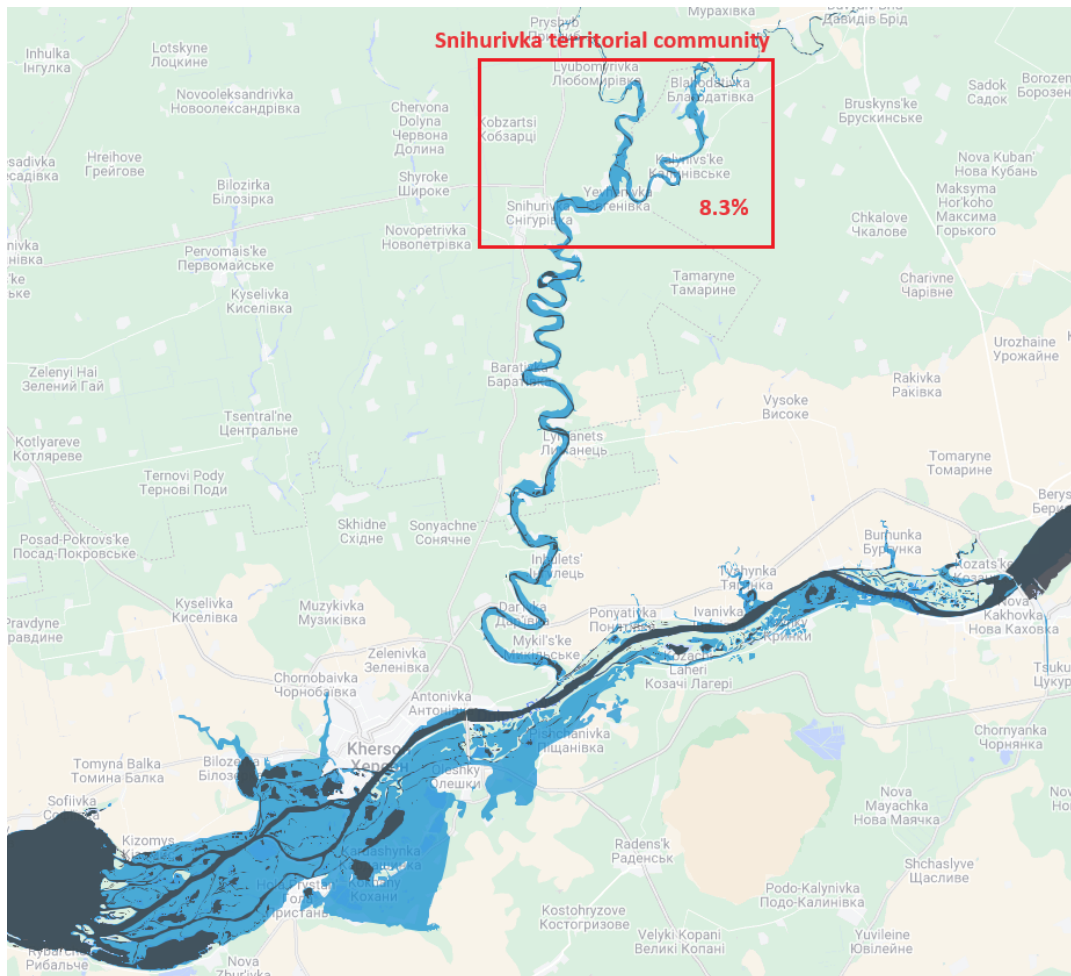
Calculations

To estimate the total area of agricultural lands flooded (A_t) and the total losses (L_t) from flooding, given the specific data for the Snihurivka territorial community, we can use the proportion (P_s) of the Snihurivka values (A_s and L_s) relative to the overall values.

The proportion of P_s is given by:

$$P_s = \frac{A_s}{A_t} = \frac{L_s}{L_t}$$

Calculation of total area

To find the total area of agricultural lands flooded (A_t), we rearrange the proportion equation:

$$A_t = \frac{A_s}{P_s}$$

Values: $A_s = 416{,}21$ he (Table 1); $P_s = 0{,}083$

Performance of the calculation:

$$A_t = \frac{416.21 \ he}{0{,}083} \approx 5015$$

Roughly rounded the approximate area of agricultural lands inundated after the Kakhovka Dam breach is **5000 he**.

Calculation of total losses

Similarly, to find the total losses due to flooding (L_t), we use the same proportion:

$$L_t = \frac{L_s}{P_s}$$

While P_s remains the same (0.083), we can calculate L_s based on the average production rates for Snihurivka territorial community and official sale prices ($Price_x$) for specific crops. Production rate for each crop equals area of crop (A_x) times average regional yield for this type of crop (Y_x).

$$L_s = (A_b \times Y_b \times Price_b) + \left(A_{sf} \times Y_{sf} \times Price_{sf}\right)$$

Where:

A_b and Y_b – area and average yield of spring barley in the Snihurivka territorial community;

A_{sf} and Y_{sf} – area and average yield of sunflower in the Snihurivka territorial community;

$Price_b$ and $Price_{sf}$ – official sale prices for spring barley and sunflower respectively.

Our proportion can be expressed as the following:

$$L_t = \frac{(A_b \times Y_b \times Price_b) + (A_{sf} \times Y_{sf} \times Price_{sf})}{P_s}$$

Values:[6]

Crop type	Area (he)	Yield (MT/Ha)	Price (USD/MT)
Sunflower[7]	315	2	610.4
Spring barley	101.18	3.1	214.9

Performance of the calculation:

$$L_t = \frac{(315 \times 2 \times 610.4) + (101.18 \times 3.1 \times 214.9)}{0.083} \approx \frac{451957{,}1}{0{,}083} \approx 5445266{,}3 \text{ USD}$$

Roughly rounded the approximate losses resulting from inundation of agricultural areas after the Kakhovka Dam breach are **5,4 million USD**.

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[6] Consolidated from Tables 1, 2, 3

[7] For ease of calculations, alfalfa, vegetables and winter crops were included into sunflowers calculations. This does not affect the outcome due to negligible areas of those crops.