

UNDP GEF project
“Best practices of Fertilizers Reduction from
Agricultural Lands in Upper Tisza basin, Ukraine”

STRATEGY

of nutrients reduction in Siltse and Zarichya



Uzhgorod 2010

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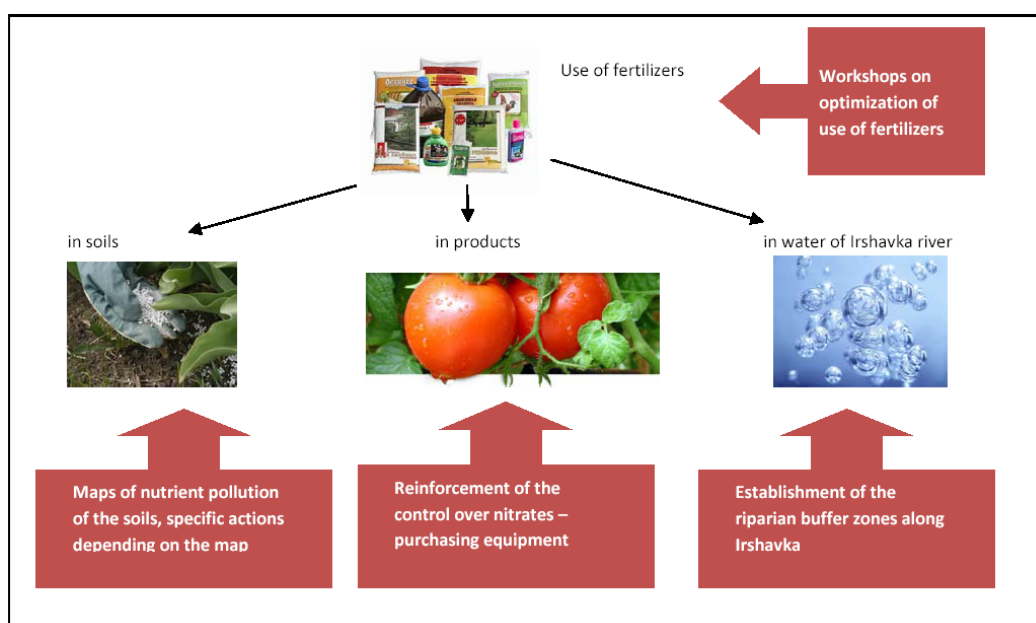
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Introduction

This publication is prepared and published in frame of the implementation of the demonstration project “**Best practices of Fertilizers Reduction from Agricultural Lands in Upper Tisza basin, Ukraine**”. The project is implemented by NGO Zakarpattya Oblast organization of All-Ukrainian Ecological League in frame of the Living Water Exchange: A GEF/UNDP Project Promoting Nutrient Reduction Best Practices in Central and Eastern Europe.

The project is being implemented in Ukrainian part of Tisza basin in Zakarpatska Oblast. The selected region in Zakarpattya – *Siltse* and *Zarichhya* village are the most representative in the region because it is the center of early vegetables growing in the green houses. The settlements are located in Irshava rayon of Zakarpattya Oblast, on both sides of Irshavka river, which flows into Borzhava, Upper Tisza basin.

The overall objective of the project is to demonstrate cost-effective measures to reduce nutrients loads by means of proper agricultural practices using Irshavka river as example.



Logo of the project: “Produce for People Without Damage to the Nature”

Project duration: 10 months (1/11/2009 – 31/08/2010).

Cooperative partners:

- Zakarpattya Oblast State Project-Technological Center of Protection of Soils Fertility and Quality of Production
- Association of farmers of Irshava rayon
- Village councils in Zarichya and Siltse, Irshavsky rayon, Zakarpatska Oblast
- Zakarpattya Water Management Board, Irshavsky Interrayon Department
- Irshava Rayon State Administration

1. Natural state of the land in Zarichya and Siltse

According to the Tisza basin Analysis 2007, prepared by ICPDR, Ukrainian part of the Tisza basin is among “leaders” in terms of nutrient pollution. So Ukrainian part of Tisza basin – Zakarpattya Oblast is the most polluted by nutrients among Tisza countries. The selected region in Zakarpattya – Siltse and Zarichhya village are the most representative in the region because it is the center of early vegetables growing in the green houses. The settlements are located in Irshava rayon of Zakarpattya Oblast, on both sides of Irshavka river, which flows into Borzhava, Upper Tisza basin. Around 80% of the working population of the villages is involved in growing of early vegetables. Around 2/3 of area of the communities are used to grow them. The farmers collect 2-3 harvests (cabbage) per year, using different biological additives, herbicides, mineral fertilizers.



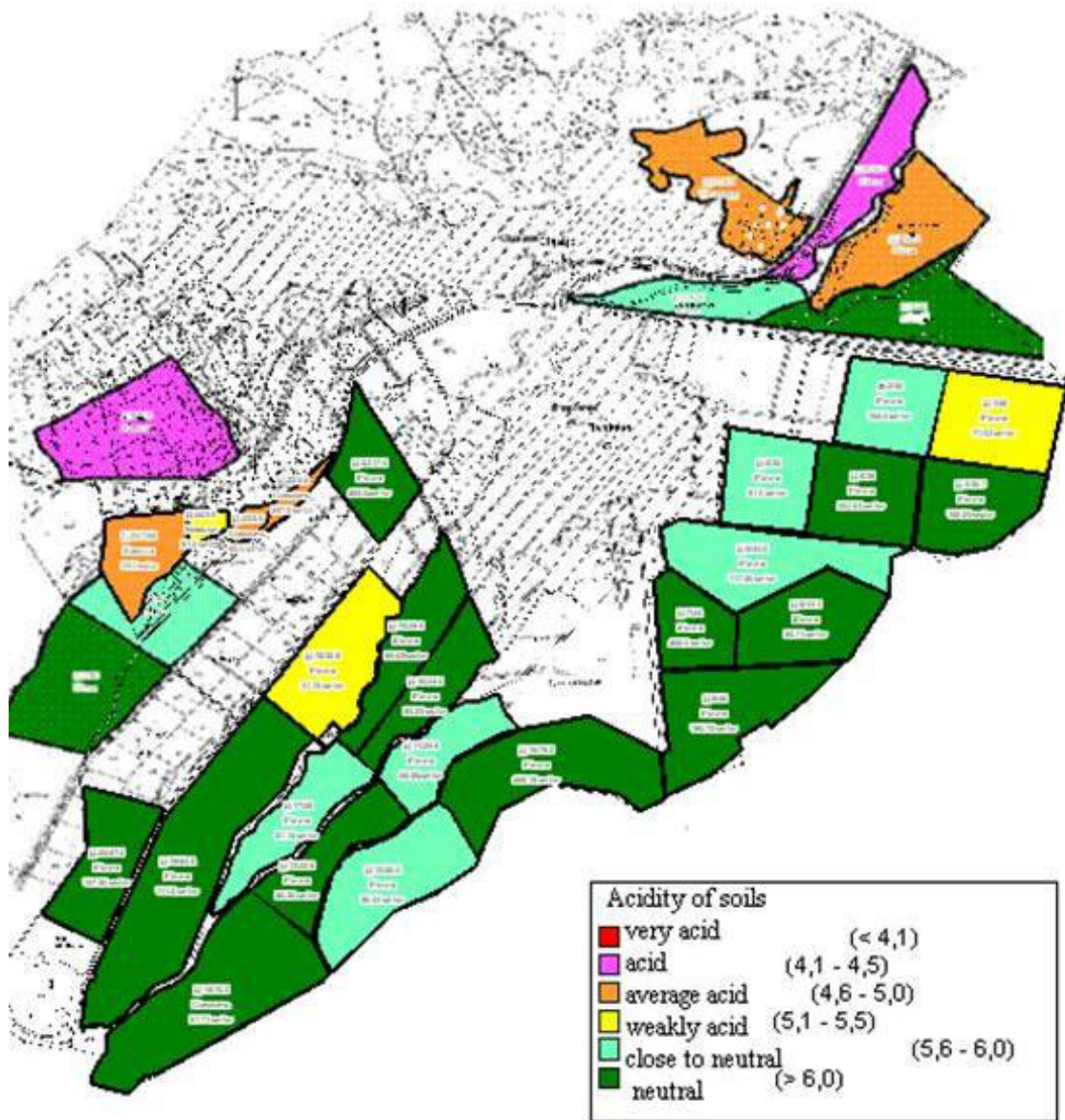
Map 1. Project area at land use map of ICPDR

In frame of the project, agrochemical researches of soils of the pilot area were conducted, which allowed to assess soil fertility.

- **By acidity**

Most of lands of Zarichya village are neutral or close to neutral soil reaction, which is advantageous for agriculture. In Siltse soil acidity is different and changes from very acid to neutral (Picture 1 and 2).

In case of increased acidity of soils, plants feel lack of calcium. It leads to atrophy of upper buds and roots, very large branching of roots. Therefore, farmers periodically do liming, insert a lot of organic fertilizers and plough down rye rests. Therefore, reaction of soil at the territory of these two villages is better than in other settlements of the Irshava rayon.



Picture. 1. Map of soil acidity

Advice

To reduce soil acidity it is necessary to conduct liming. It is economically useful to use limes of local Priborzhava deposit, located in 20 km from pilot area, which decrease transport costs of liming.

- *By humus contains*

Despite of intensive use of fertilizers, level of humus does not exceed the average level and is between 1-3% (Picture.2).

Advice

For vegetables growing at the land with low contains of humus it is necessary:

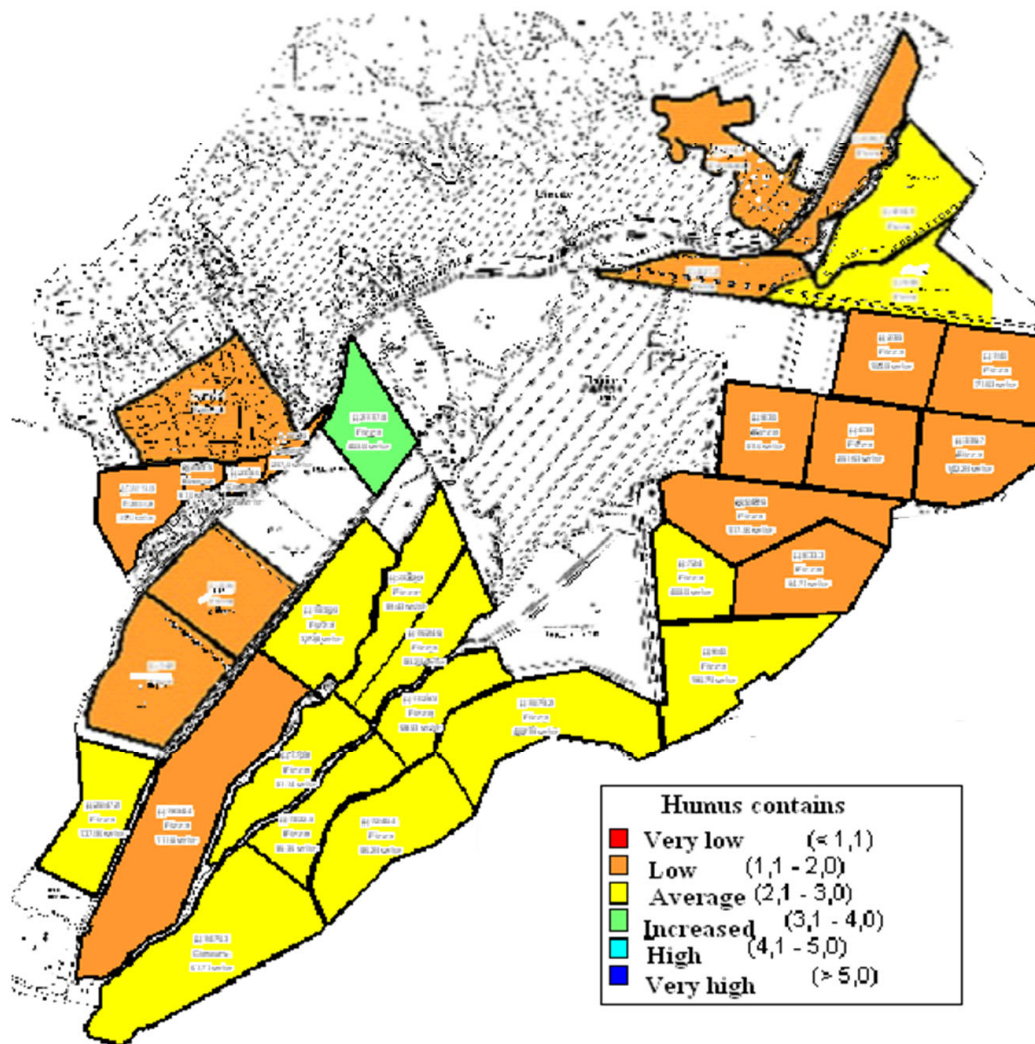
- *to put organic fertilizers up to 40-80 t/ha and put them at the depth 20 - 30 cm;*
- *In case of absence of manure it is advisable to use new organic fertilizers such as Agrovit-Kor, Proferm, Agrokor;*
- *To leave and to plough down rye rests;*
- *To leave after winter wheat a high stubble;*
- *If putting cut straw, it is advisable to add nitrogenous fertilizers (8-10 kg/ha). This allows to mineralize straw and to decrease detoxication;*
- *To grow leguminous plants at the fields.*

Important to know

Environmental advantages of use of straw:

- *Large amount of organic matter is utilized, which is mineralized in the soil;*
- *Straw, being decomposed in the soil, during a long period of time does not pollute it with high concentrations of nitrite nitrogen, organic phosphorus and potassium;*
- *There is a balance between straw decomposting and use of organic matter by plants, which does not lead to washing out of organic matter in the river;*
- *Evenly distributed straw in the field in hot summer time protects soil from over-drying and compression;*
- *Introduction of straw in the soil promotes the development of soil fauna, which leads to increased activity of bacteria, rain warms etc, improving agrochemical and physical soil features.*

Researches show the **use of biohumus** and **warm compost** also positively affects agrochemical, physical-chemical and biological features of soil (see chapter 3 for more details).



Picture. 2 Map of humus contains

- **By contains of nitrogen**

Nitrogen at the pilot area is **very low** (Picture 3). In case of low nitrogen, plants grow slowly; contains of chlorophyll reduces, especially in old leaves, which shorten the life of plants.

Too much of nitrogen leads to extensive growth of leaves, decreased plants immunity towards unfavorable meteorological conditions, fungic and bacterial diseases; delays in growth and ripening; it also decreases the size of fruits and seeds and can lead to worsening of quality of production.

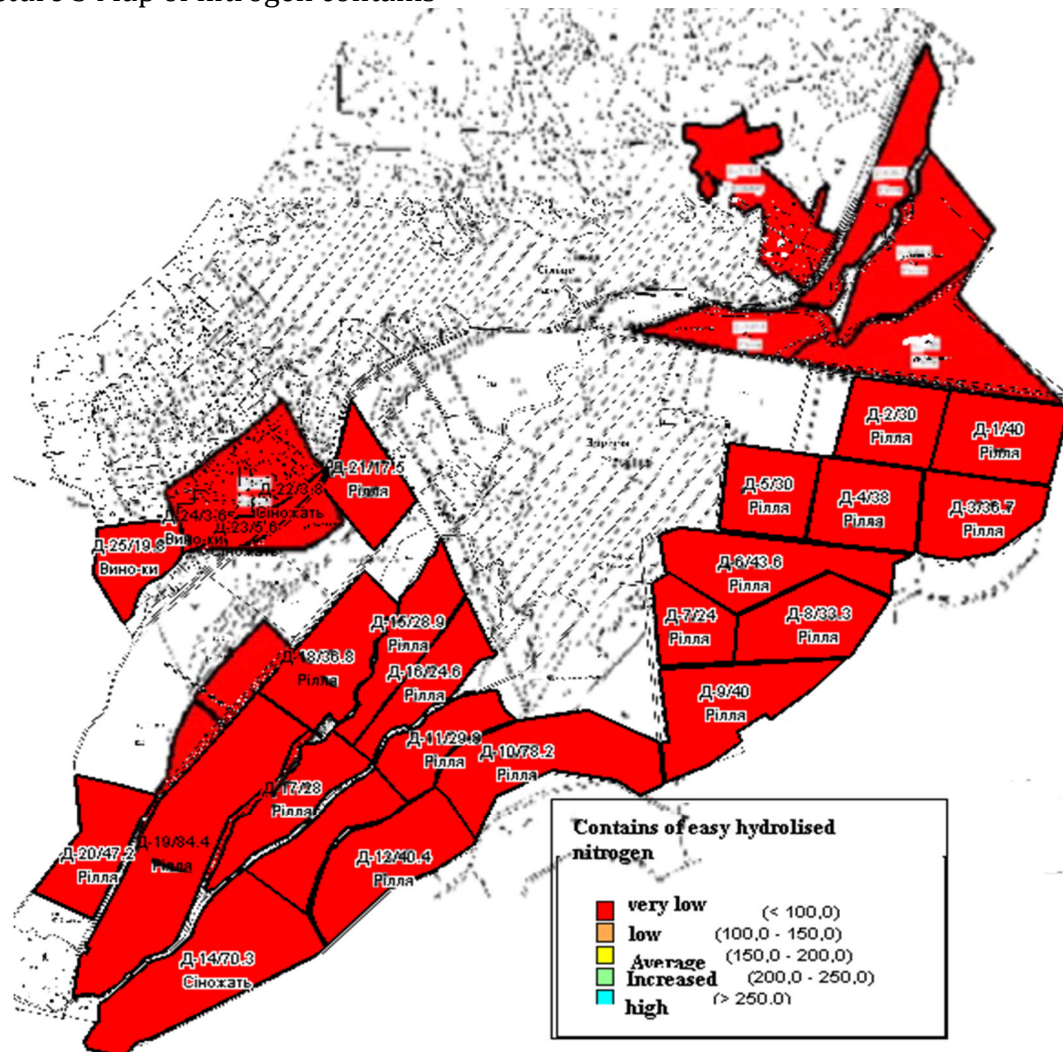
Advice

- For good growth of vegetables it is necessary to use nitrogen fertilizers (100-220 kg/ha) depending on the type of cultures and seasons. It is better to use organic fertilizers (30 - 60 t/ha of manure) as a source of nitrogen fertilizers;
- In order to avoid accumulation of nitrogen in plants, nitric fertilizers should be used by parts: main soil improvement in spring - 40 -60 % of nitrogen, 10 - 20 % - during planting, and the rest for additional feeding of plants. If the main soil preparation is done in autumn, and plants are planted in spring, then nitric fertilizers should be inserted in spring to avoid washing out of nitrogen during autumn and winter. So only

for winter cultures, you should insert nitric fertilizers in autumn/ winter.

- Tuber bacteria, living together with leguminous plants during vegetation period bring from air 70-200 kg of nitrogen per 1 ha, therefore it is useful to sow leguminous plants.

Picture 3 Map of nitrogen contains



- **By contains of phosphorus**

Contains of available for plants phosphorus compounds differs in Zarichhya and Siltse and changes from low to very high in Zarichhya and from very low to high in Siltse (Picture 4). Optimal phosphorus regime leads to good harvest and improves its quality, speeds up ripening of plants and development of root system and improves general immunity of the plants against fungus.

Most of agricultural plants use phosphorus during initial period of growth. Insufficient amount of phosphorus in young age of plant cannot be compensated by increased phosphorus nutrition at later period and worse the harvest. Lack of phosphorus can be seen in delay in growth and development of plants, purple and violet color of lower leaves. Extensive phosphorus can lead to decrease of harvest due to too large speed of development, untimely death of leaves and early ripening.

Advice

- *Very high concentration of phosphorus in soil shows that it is ineffective in insert phosphorus mineral fertilizers;*
- *At land with lack of phosphorus, during the main cultivation of land it is advisable to insert 40-70% from the total amount of phosphorus depending on the culture.*
- *Phosphorus is crucial for plants at the beginning of the growth. Therefore for the soils with the lack of phosphorus during planting it is important to insert 10-20 kg/ha of phosphorus fertilizers, better superphosphate (100-200 kg/ha).*

- *By potassium contains*

The similar situation is with contains of potassium (Picture 5) Potassium supports water keeping capacity of plants. It positively affects establishment of carbons and fat in plants and support cold and fungus immunity of plants, improves their taste.

Sufficient contains of potassium weakened negative effect of excessive nitrogen, supports hardness of cereals stem and their immunity against falling down and hampers too early ripening in case of excessive phosphorus. In general, soils of pilot area contain average amount of potassium.

Advice

To support good balance of potassium in soil, the following actions are required:

- *To insert potassium fertilizers together with nitrogen and phosphorus fertilizers;*
- *Amount of fertilizers inserted should correspond to the standards and cultures grown;*
- *Potassium fertilizers in acid soils are more effective if combined with liming;*
- *For vegetables, potato, cereals and grape it is better to insert chlorine-free fertilizers;*
- *Potassium fertilizers should be inserted in soil at all stages: during main cultivation, during planting and plant nutrition.*

Picture. 4 Map of phosphorus contains

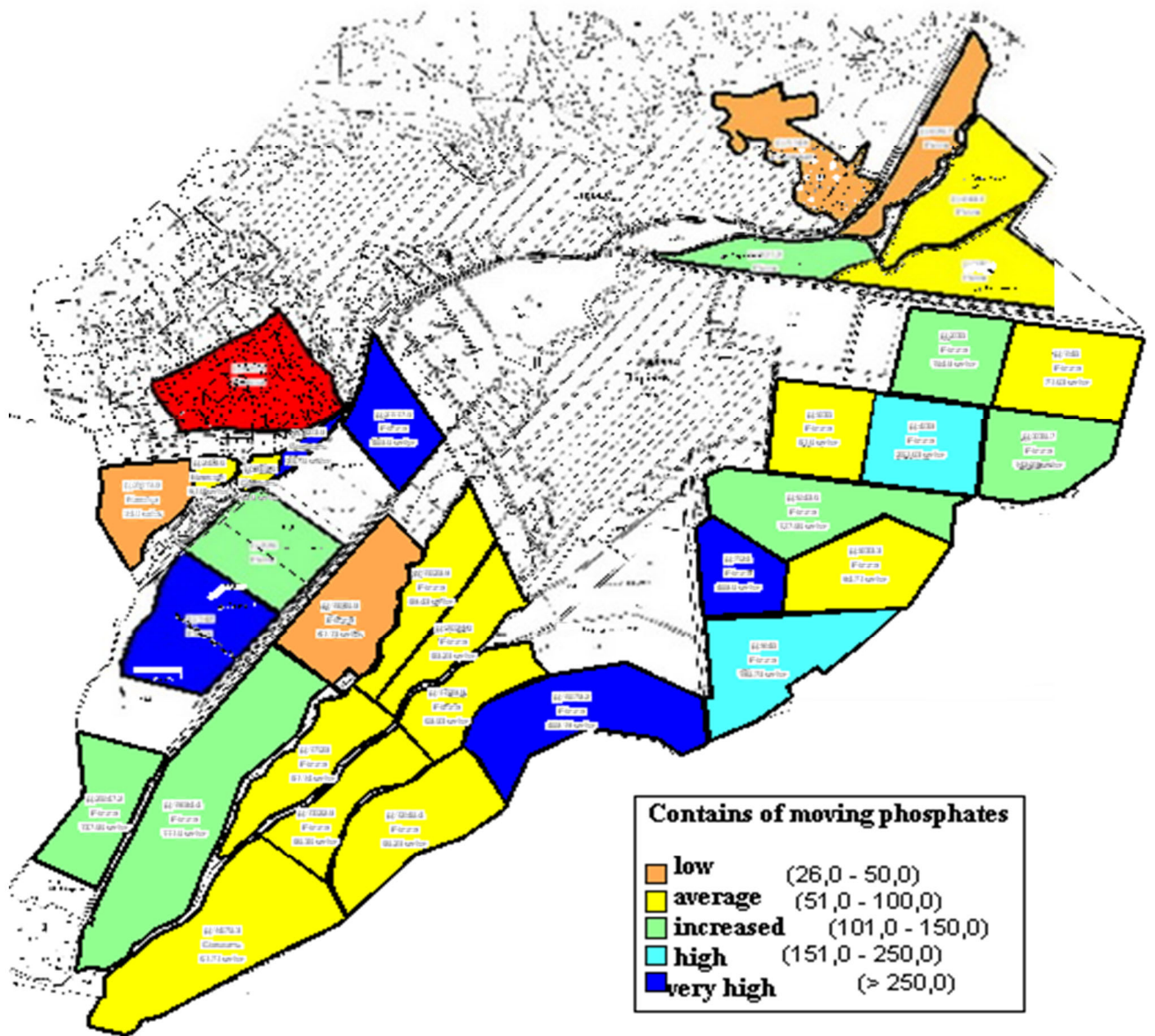
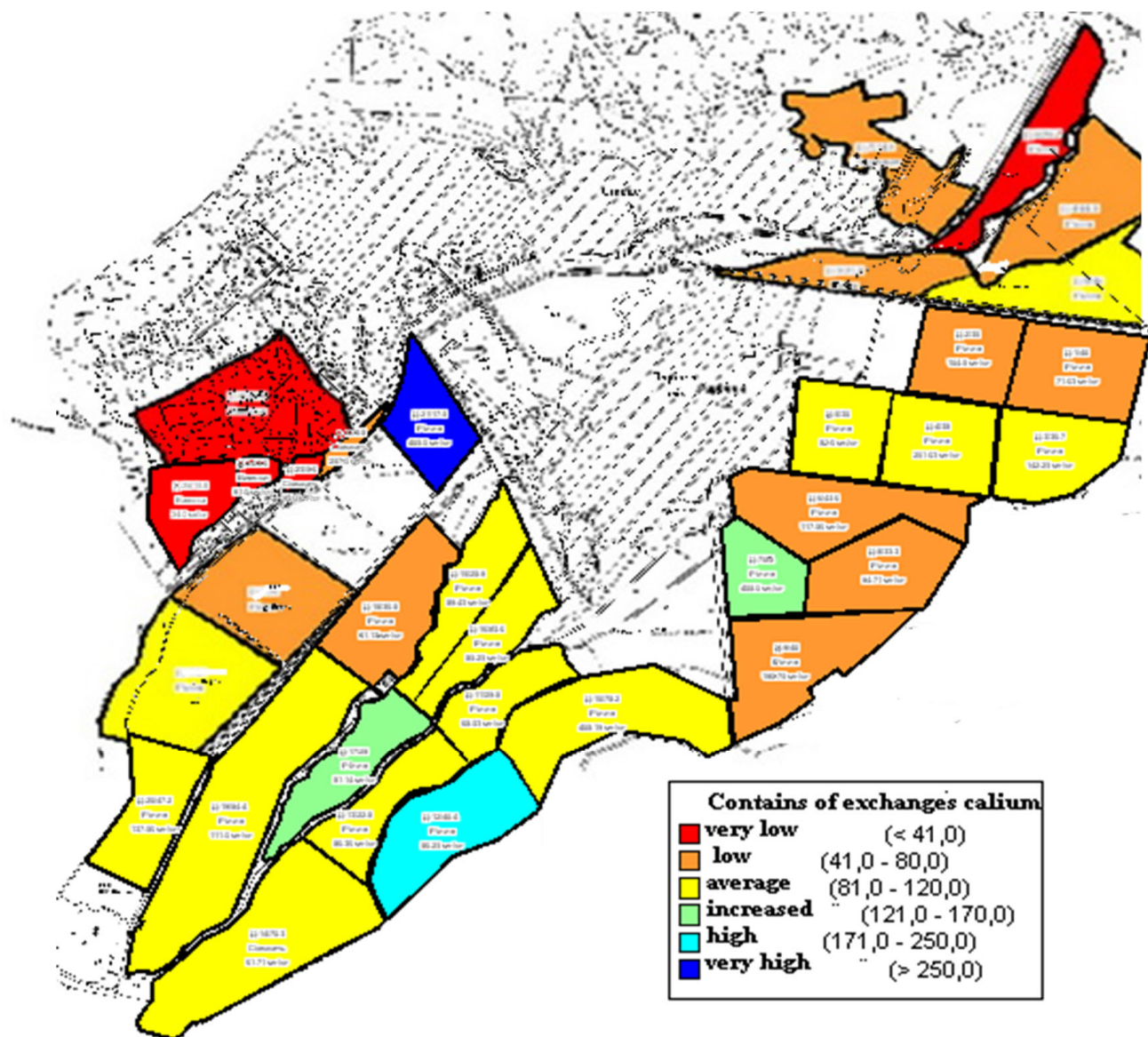


Рис. 5 Map of potassium contains



2. Man-caused impact at Irshavka river

Main examples of man-caused impact at Irshavka river are as follows:

- Littering at river banks
- Pollution of the river by untreated wastewaters
- Improper use of fertilizers
- Washing of cloth in the river
- Pollution coming from transport
- River silting and ruining of the banks.

During agrochemical survey of soils and hydrochemical analysis of water quality in Irshavka river within Zarichya and Siltse, man-caused pollution was identified.

- *By contains of heavy metals in soils*

Pollution by heavy metals of soils of Zarichya and Siltse is caused by to the following natural and man-caused reasons:

- Polluted precipitation;
- Discharge of untreated wastewater;
- Excessive insertion of mineral fertilizers (especially phosphorus);
- Inundation of illegal dumping places, industrial waste and transport.

In case of rain with heavy metals, fertility layer of soils is being ruined. Contains of heavy metals in soils is also related to deposits of different polimetallic ores.

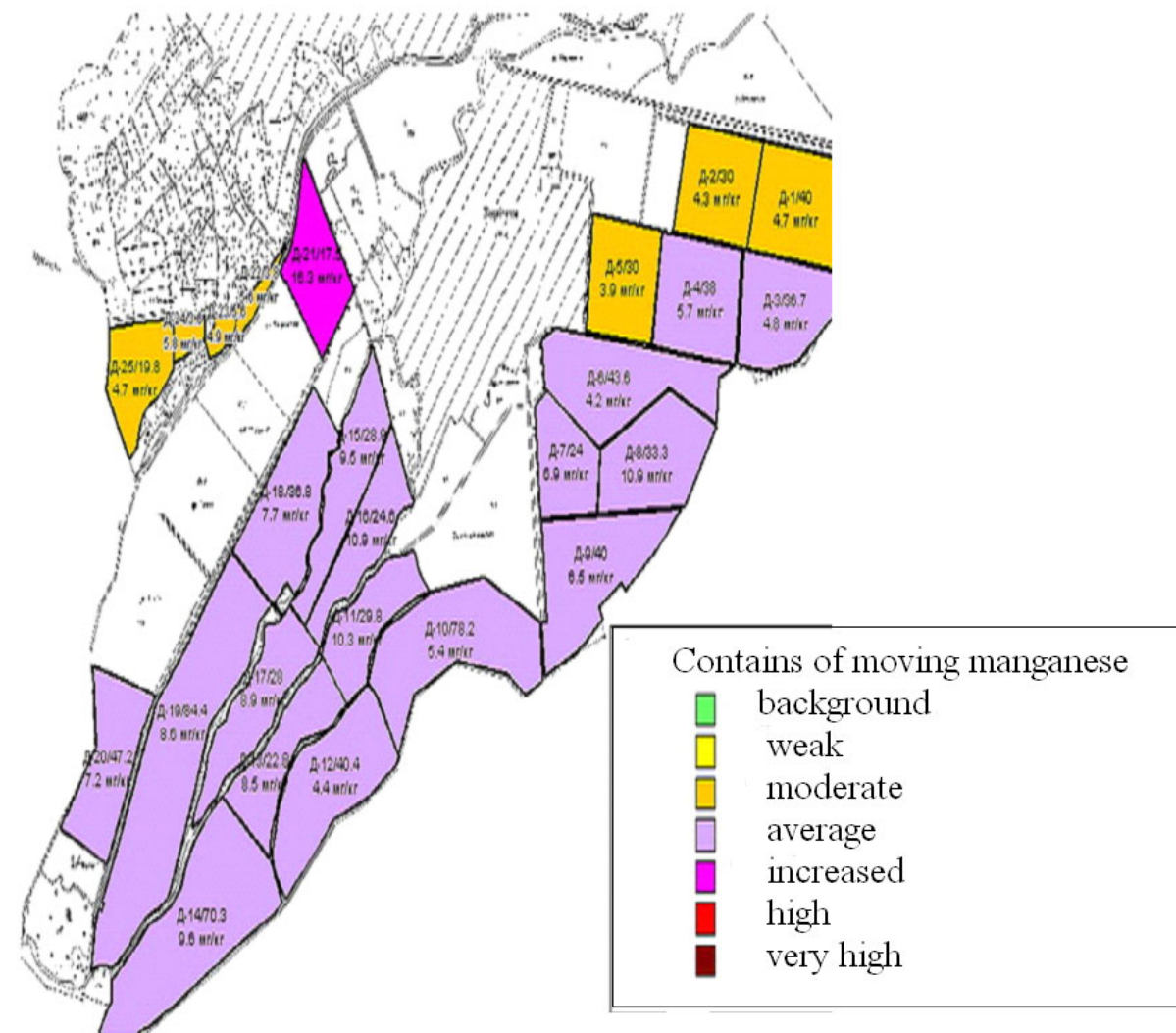
Local farmers intensively use chemicals with big ratio of copper. If to use copper containing chemicals during many years, concentrations of copper and zinc in soil grow. It is especially the case for old grape yards.

Agrochemical research of soils of Zarichya and Siltse villages showed that concentrations of heavy metals are within the MACs (see Table 1. and Pictures 6-9).

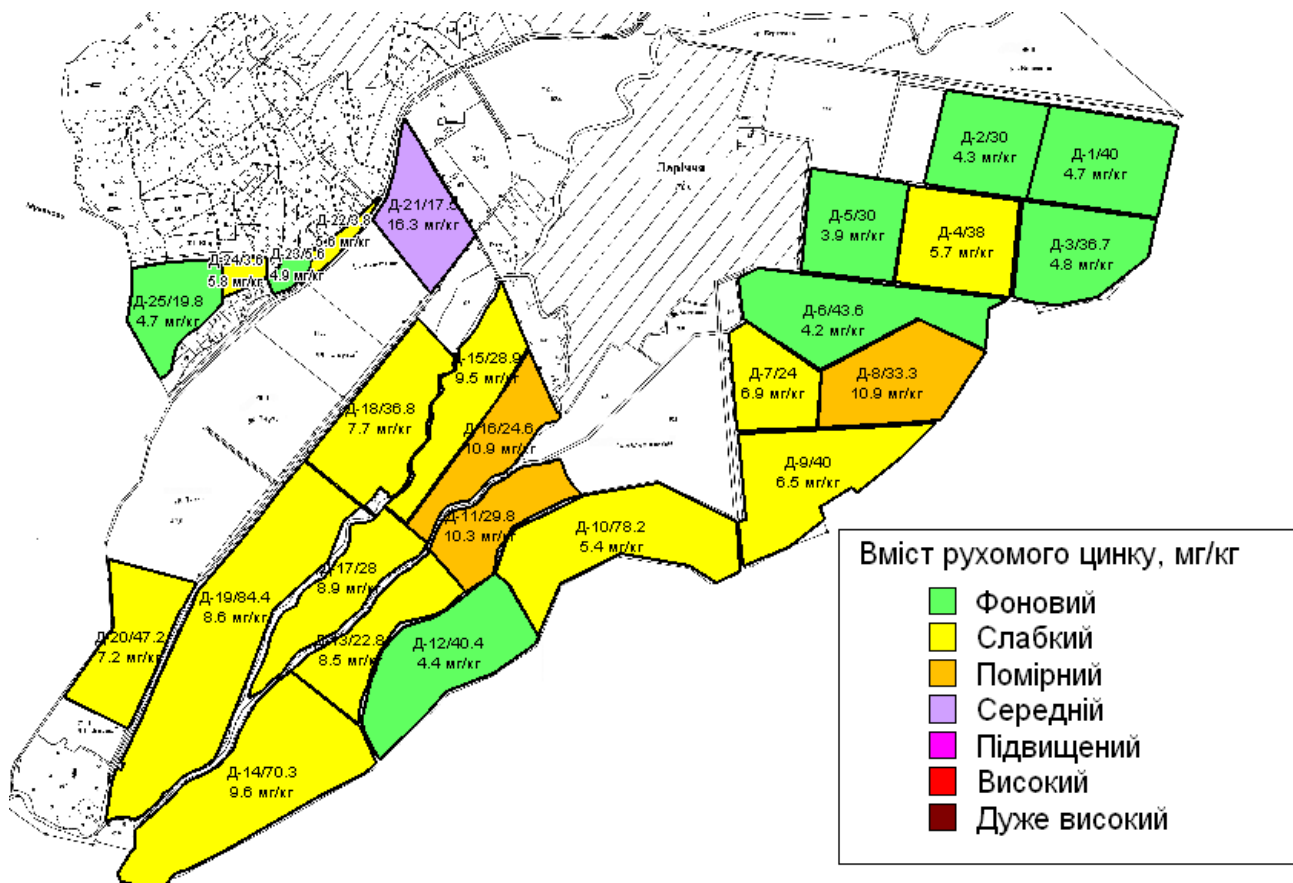
Table 1. *Average contains of heavy metals in soils*

Metal	Result of measurement, mg/kg	Maximum admissible concentrations (MAC), mg/kg	Deviation from MACs, %
<i>Manganese</i>	<i>104,5</i>	<i>150,0</i>	<i>69,7</i>
<i>Zinc</i>	<i>2,57</i>	<i>15,0</i>	<i>17,1</i>
<i>Cadmium</i>	<i>0,23</i>	<i>0,5</i>	<i>46,0</i>
<i>Copper</i>	<i>0,35</i>	<i>3,0</i>	<i>11,6</i>
<i>Lead</i>	<i>0,92</i>	<i>2,3</i>	<i>40,0</i>

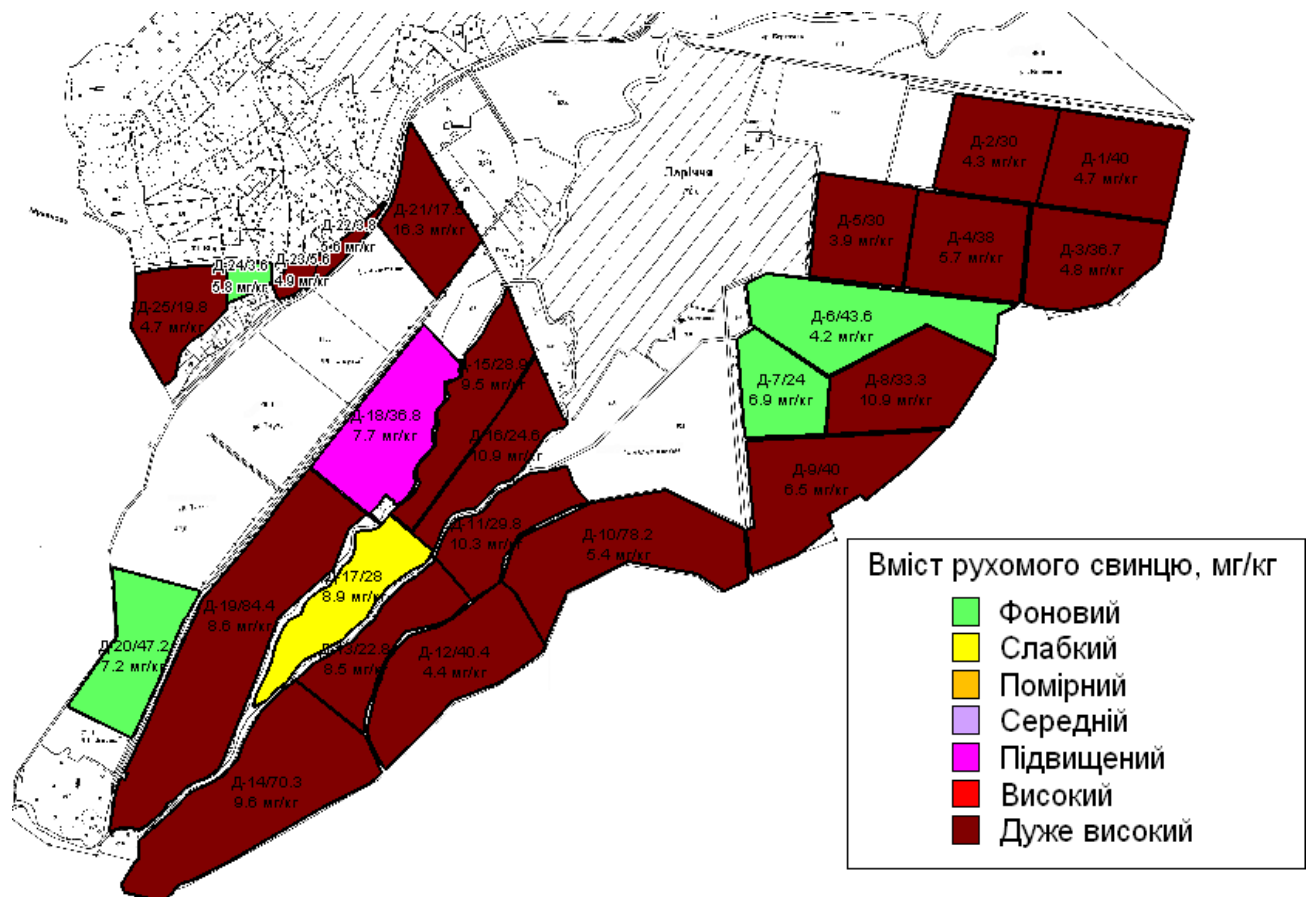
Picture 6. Map of manganese contains



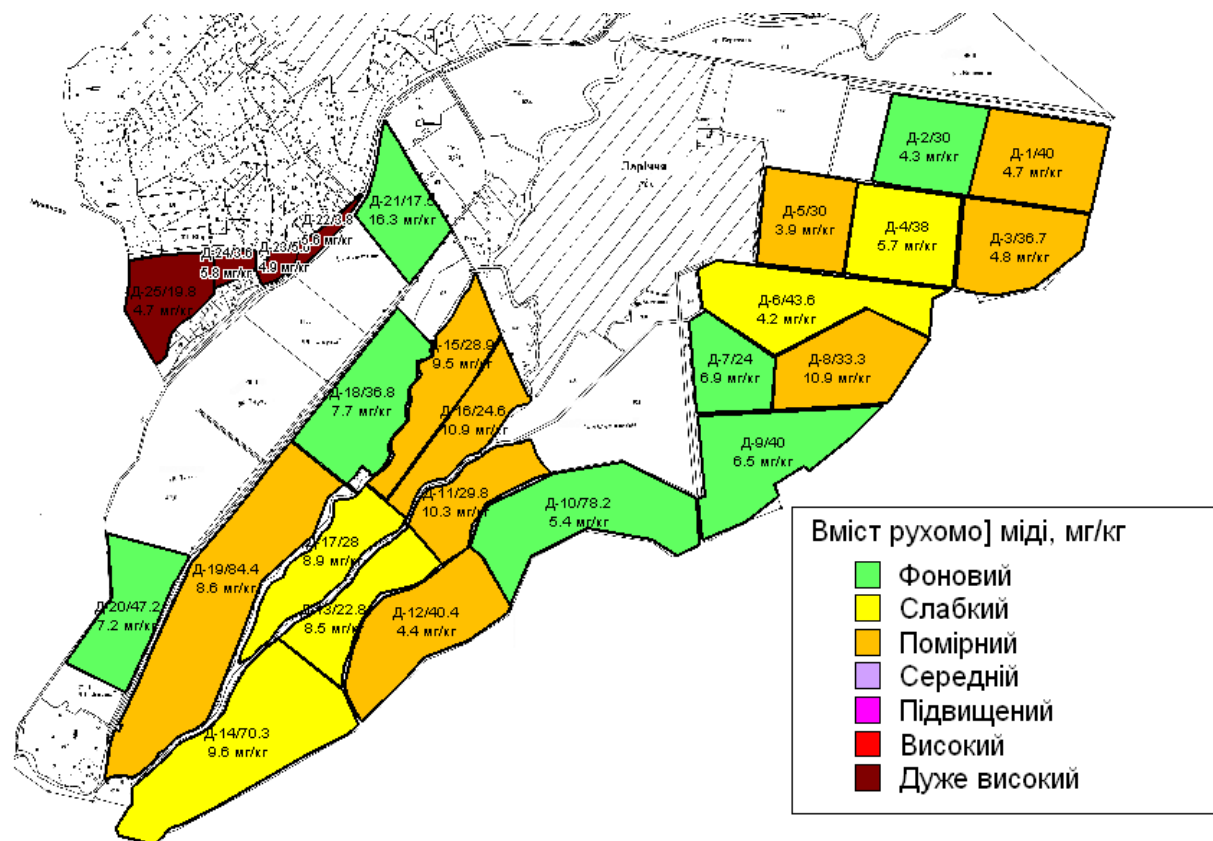
Picture 7. Map of zinc contains



Picture 8. Map of lead contains



Picture 9. Map of copper contains



By contains of pesticides in soil

In 60-70s of the last century, in order to protect multi-year plants, chlorine-organic pesticides (dichloro-diphenyl-trichloroethane etc) and phosphorus containing pesticides (*Trichlorfon*), fungicides (*bordeaux, copper sulphates*) were used.

Agrochemical study of soil of Zarichya and Siltse villages regarding contains of pesticides of chlorine-organic group showed that their concentrations are much higher than MAC (See Table 2.).

Table 2. *Total chlorine-organic pesticide load in soils*

Settlements	Result measured, mg/kg	Maximum admissible concentrations (MAC), mg/kg	Deviation from MAC, %
<i>Zarichya</i>	<i>1,215</i>	<i>0,45</i>	<i>270</i>
<i>Siltse</i>	<i>0,975</i>		<i>217</i>

Such high amount of pesticides of chlorine organic group is caused by uncontrolled use of chemicals by farmers during many years.

Important to know

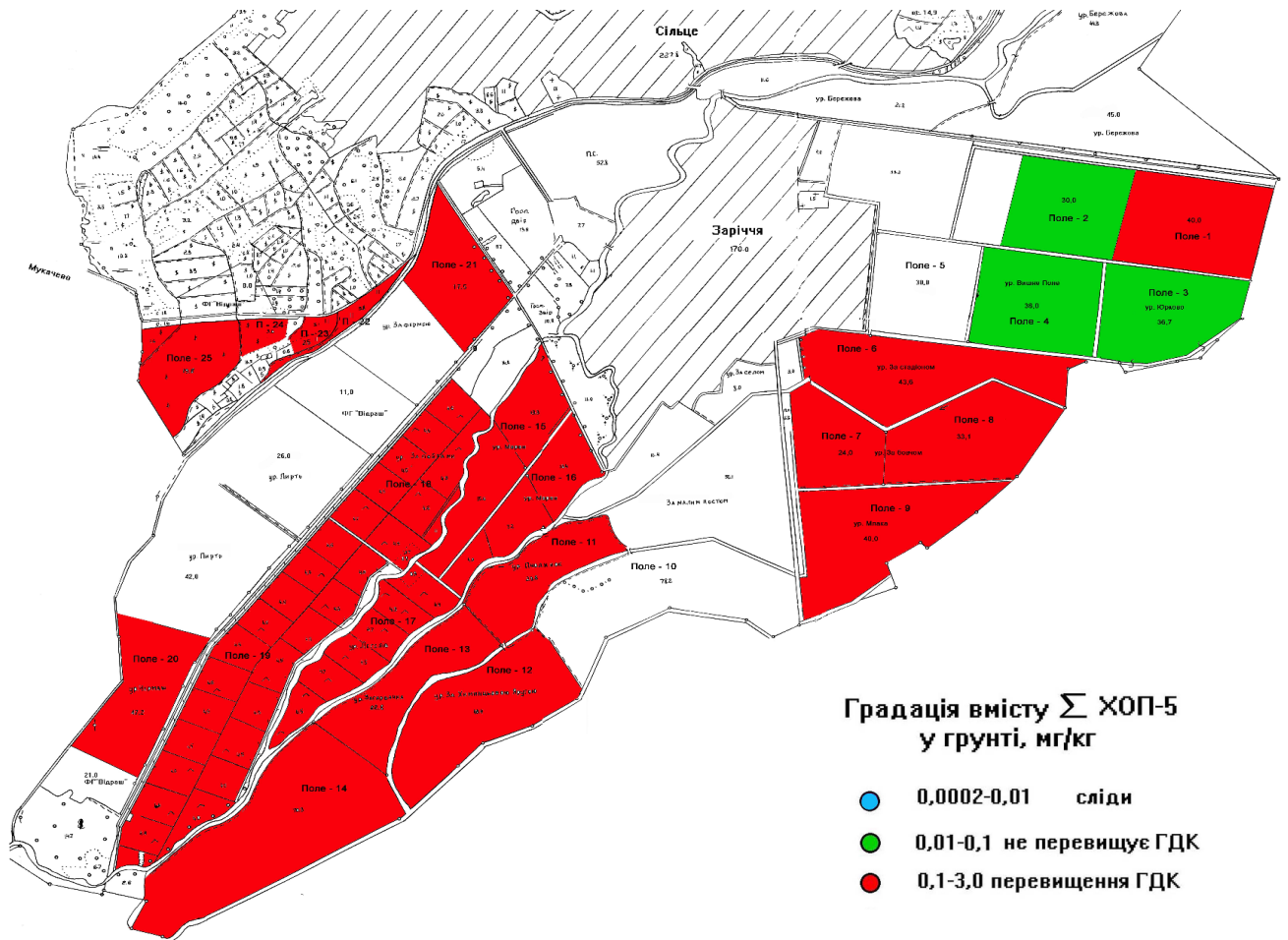
The pesticide load at soil is constantly growing. In 1990 it was 0,28 kg/ha, and in 2009 - 0,69 kg/ha. It supports migration of poisonous substances soil into the plants.

Advice

In order to avoid mistakes in pesticides dosing please contact the rayon station of plant protection.

Results of agrochemical study of soils are given at the following map (Picture 10).

Picture 10 Map of contains of chlorine-organic pesticides in soil



Water quality in Irshavka river

Study of surface water quality in Irshavka river was conducted in three monitoring points (transport bridges across Irshavka between Loza, Siltse and Zarichya villages) during December 2009 – July 2010.

Assessment of chemical and physical-chemical elements of surface water of Irshavka can be divided at such components:

<i>Oxygen regime</i>	Presence of dissolved oxygen in water, capable to dissolve organic pollution of water course and amount of organic pollution, which a river can purify itself.
<i>Nutrients contains</i>	Presence of nitrogen and phosphorus in water
<i>Heavy metals</i>	Presence in water of such elements as zinc (Zn), copper (Cu), chrome total (Cr), lead (Pb), cadmium (Cd), nickel (Ni).

By oxygen regime and contains of organic matter water quality in Irshavka river corresponds to 1st **(very good)** class of quality in monitoring stations Loza and Siltse and to the 2nd **(good)** class of quality in monitoring station in Zarichya. The reason for worsening of class of water quality is uncontrolled discharges of untreated wastewaters and aggregation of organic fertilizers, especially manure at river banks. Some households do not have cesspools, and wastewaters from toilets and bathrooms are discharged directly into the river.

Important to know

*The level of pollution of Irshavka by organic matter between Siltse and Zarichya is **constantly growing!***

Advice

Until centralized wastewater system will be established in Zarichya and Siltse, each household should create its own cesspools.

Contains of nutrients (nitrogen and phosphorus) in Irshavka river corresponds to the 2nd **(good)** class of quality of surface waters.

Important to know

Main sources of nitrogen and phosphorus are communal wastewaters and polluted groundwater from agricultural fields.

Concentrations of nitrogen in summer is growing due to bacterial processes of nitrogen transformation due to the above mentioned factors and a natural factor – decomposing of plants.

Advice

Taking into account that river Irshavka is quite overgrown by plants, it is necessary to conduct selective clearance of the riverbed (after agreeing of action with local water management board)

Contains of heavy metals in Irshavka river is at the level, which corresponds to 1st (very good) class of quality and only for lead the values are between 2nd (good) class and 3rd (satisfactory) class of quality, which is the result of impact of transit transport and washing out of lead from soils of Irshavka floodplain.

Important to know

*In spring-autumn season, water quality in Irshavka river between Siltse and Zarichya villages is **worsened**, due to intensive growing of vegetables. Namely in summer 2006 and 2007 (selective investigative monitoring), water quality in Irshavka was within 3rd (satisfactory) class of quality. By nitrogen nitrate and phosphorus general, it was in some places even 4th (bad) class of quality.*

If to compare results of monitoring of Irshavka river at Loza village and Siltse and Zarichya villages, it is worth to mention that work of wastewater treatment facilities of Irshava town does not affect significantly the water quality between Siltse and Zarichya villages. **The water quality deteriorates exactly between Zarichya and Siltse.**

3. Actions to prevent pollution of groundwater and soil

- *Establishment of riparian zone*

In order to decrease the pollution of Irshavka river due to washing out of nutrients and mineral fertilizers from agricultural fields near the river it is necessary to restore riparian protection zone. Riparian zone is called a *protection zone* because its aim is to protect river from various pollutions.

As banks of Irshava river within the settlements of Zarichchya and Siltse are made of loamy soils, they can be easily affected by bank erosion and can be destroyed. *Great ploughing of floodplain* (sometimes – up to river itself) intensifies bank erosion, which further results in silting and overgrowth of riverbed. *Construction in the riparian protection zone* extremely negatively affects the state of river. Because of intensive construction within the riparian zone, river flow capacity reduces, which creates impoundment during floods.

Important to know

*In frame of the project a fruit alley with plum trees, currants and arrow-wood has been planted on both banks of Irshavka river, along the territory of Zarichchya and Siltse (total length about 6 km). **This alley is a beginning of riparian protection zone creation, and claims to be entered to the Record Book of Zakarpattya as the longest plum tree alley!** It has already become a distinctive symbol of these settlements today.*



Establishment of riparian zone along Irshavka river

Advice

In general, in order to reduce bank erosion, bushes and trees should be planted in the form of a continuous line 1-3 m wide, at the distance of 3-5 m from the river. Riparian zone planted under the project (plum trees and currants) shall be preserved and expanded. Each of you shall take care of planted trees and bushes near your garden!

- **Less nitrates in vegetables**

The amount of fertilizers is calculated depending on the quality of field for a particular crop. Among vegetable crops the most nitrates are accumulated in cabbage, pumpkin, celery, Solanaceae, and among other crops – red beet, lettuce, spinach, radish, white radish.

Important to know!

Admissible (safe) daily dose of nitrates for human body makes 5 mg/kg of a person's weight. For an adult person with the weight of 60-80 kg 325 mg of nitrates consumed during a day shall not cause any harm to his health.

One should know that nitrates accumulate mainly in the roots, stems, rods and veins of leaves along which nutrients are conveyed from soil. So, beet, radish carry 5-10 times more nitrates in their lower part than carrot, where most nitrates accumulate in its core. In leaf crops the biggest volume of nitrates accumulates in stems and veins, the least volume – in leaves. Cucumbers and marrows have the same amount of nitrates, both in their pulp and skin, but more nitrates accumulate near their tail and less nitrates – on the top. Nitrate concentration also depends on the weight of vegetables. As a rule, small and big fruits have more nitrates than the middle-size fruits.

Important to know!

Excessive content of nitrates can be found in early cabbage, beet, radish and onion.

Time of vegetables harvesting is also of big importance. Lettuce, dock, spring onion, parsley, dill have the biggest amount of nitrates in the morning, therefore it's better to harvest them in the afternoon, and the roots are better to be harvested in the morning as they have 20-30% less nitrates at that time.

Another peculiarity is that early carrot, beet have more nitrates than in "adult" fruits, while young cucumbers have 2-3 times less nitrates than adult cucumbers. It is good to soak vegetables in water before eating them. 2-4 hours of soaking make up to 30% of nitrates "transfer" to the water.

Advice

When you buy vegetables, ask the sellers for certificate of nitrate concentration in the product you buy. It will protect your health and health of your nearest and dearest.

Important to know!

The vegetables that are in the process of growing contain much more nitrates than already grown vegetables. It is especially noticeable on cucumbers and radish – big cucumbers and radish contain much less nitrates than small ones.

Table 4 Maximal admissible nitrate concentration in plants and water

Name	Under cover, mg/kg	Open ground, mg/kg
Potato		250
Cabbage (before September 1 st)		900
Late cabbage		500
Early carrot		400
Late carrot		250
Tomatoes		150
Cucumbers	300	150
Beet		1400
Onion		80
Spring onion	800	600
Leaf crops (lettuce, spinach, dock, parsley, dill)	3000	2000
Sweet pepper	400	200
Marrows		400
Water, mg/l	45	



Important to know

It should be noted that in frame of the project, nitrate meters “SOEKS” have been purchased for both village councils.

These nitrate meters are very simple in use, metering rod is inserted into a vegetable, and the display shows nitrate concentration in this vegetable and respective admissible level.

Measure nitrates in your products!

According to the data of selective study of nitrate concentration in the agricultural products of Zarichchya and Siltse villages made in spring 2010, no excessive concentration of nitrates in cabbage and cucumbers has been detected. It proves products conformance to consumer norms!

- **Less pollution of soils!**

Agrochemical studies show that soils on the territory of village councils are in their natural state, and they can either remain clean or become polluted depending on their loading.

Advice

1. Add mineral fertilizers into **holes or tracks**. It reduces losses of gaseous nitrogen compounds in 1,5-2 times.
2. Combine **mineral and organic fertilizers**, which will reduce the excessive nitrates in soil and plants.
3. Add **ground straw into soil**, it is able to bind movable nitrogen compounds, which will result in reduction of concentration and washing of nitrates away from soil.

4. *Fields should be left without crops as long as possible. It is useful to introduce grass into crop rotation.*
5. **Alfalfa** *with its deep root system is able to absorb nitrates from the depth of 2-4 m, preventing from their penetration from ground water. It also improves nitrogen level in the soil.*

It is crucial to use ONLY fertilizers included to the List of Pesticides Allowed For Use In Ukraine, and to follow their application term and methods (Ref. to Annex 1, 2 and 3).

- ***Advantages of use of biohumus and vermiculture***

The chapter explained advantages and of biohumus and gives instructions how to start the vermiculture growing in the region.

Instead of conclusions:

Lets reduce together water pollution in Irshavka river!

When looking back how Irshavka river looked decades ago, many native residents of the older generation from Siltse and Zarichchya villages did not even think of “black clouds of future” that thicken above it. At the time clean water did not surprise anyone, people were not afraid to drink water not only from wells, but even from the river itself, and it was normal then. Today Irshavka river and ground waters filling drinking wells are more and more contaminated by intensive mineral fertilizing, use of chemicals and filtration of polluted waste waters from courtyards. An irrevocable daily negative impact on the health of local population has started, and it can unpredictably affect future generations.

Important to know!

*Permanent accumulation of polluting agents in soil in the result of intensive vegetable growing acts as a “**delay-action mine**” on this territory. When passing through soil layers, ground waters which feed the river and drinking wells are polluted with chemical elements soil is oversaturated with, instead of being purified.*

Here are five principal advices how to reduce pollution of surface and ground waters:

Advice 1.

To reduce dumping of polluted waste waters from each courtyard (waters from bathrooms, toilets, cattle sheds etc.) and putting the rubbish into Irshavka river and on the surrounding territory.

It requires:

- *Arrangement of elementary cesspools with their further pumping and removal;*
- *Mounting of biological pervious cesspools or other systems of complete biological purification;*
- *Building of compost pits which will enable receiving organic fertilizers.*
- *Arrangement of household waste gathering and removal system in villages.*

One should remember that the place for wastes is not at the river bank and bed, but in the rubbish bin.

Advice 2.

To stop washing clothes, carpets, cars and agricultural machinery in the river bed.

You can do it at home or in the specialized places (dry cleaner’s, car washes), thus saving time and receiving respective guaranteed quality. If you still decide to save money and are willing to wash your car, tractor or carper yourself, you can do it directly in your yard, providing in advance that the dirty water is dumping into insulated cesspool.

Advice 3.

Vegetables should be grown without any damage to the quality of water in the river.

*First of all, to get good crops and to protect good water quality in Irshavka river, one shall always use grounded and reasonable amount of mineral organic fertilizers and agents for plants protection. Ground waters of your gardens, greenhouses and conservatories are directly connected with surface waters of the river. So, **minimal** amount of fertilizers and various agents for plants protection is a guarantee of good quality of water and your products, which in its turn will attract potential buyers willing to get ecologically clean agricultural products which will not cause harm to their health.*

Advice 4.

Creation, expansion and protection of riparian protection zone along both banks of Irshavka river.

The riparian zone planted under the project (plum trees and currants) shall be preserved and expanded. Each of you shall take care of planted trees and bushes near your garden. If a tree has died due to any reasons (in the result of spring flooding, damage by animals, broken by wind or by unknown persons etc.), please plant a new tree or a bush. If you do not have a young plant of plum tree or currant bush, you can plant any another tree or bush (better moisture-resistant), as it will delay washing of nutrients out to the river, and will protect the river bank near your garden against erosion.

To reduce amount of pollutants coming from your fields into the river it is necessary to dig a small enclosing channel in the end of each garden, where waste waters will be partially collected and self-purified through the soil.

One shall give up destructive practice of storing organic fertilizers (pus), wastes of agricultural products (plant tops, heads etc.) and household rubbish on the river bank.

One should rather arrange his farmland so that in the end of the garden bordering with the river there is an untilled strip with grasses (clover, alfalfa etc.) at least 1-2 meters wide.

Advice 5.

Reconsideration of the situation concerning pollution of Irshavka river by the residents of villages.

In our opinion, the most effective advice is that everyone, young and old, shall reconsider his personal attitude and possible negative impact on Irshavka river. It will prevent us from leaving our children only grandfathers' memories of diving into clean water of Irshavka river and fishing in their childhood.

Your example of vegetable growing in harmony with nature will become an example for other villages in Zakarpattya region!

And while the going is good, stop and protect your river for you and for your children!

Annex 1: Insecticides, fungicides, herbicides recommended for use

The annex includes a long list of insecticides, fungicides, herbicides recommended for use in the pilot area.

Title of chemicals	Standard of se (ha/kg, l/ha)	Culture	Against what it is used?	Way and time of use	Term for the last use	Maximum number of use
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