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ABSTRACT

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There are millions of hectares of land in the Ukraine which either have been abandoned, or are farmed with a low land productivity due to severe land degradation. The Netherlands Embassy has requested a study to assess the opportunities and benefits of restoration of degraded steppe areas. The goal of this project is the restoration of degraded land and to develop more sustainable land use with a higher biodiversity. Innovative farming systems are proposed which are both economically and environmentally sustainable agricultural production systems. This will improve the livelihood of farmers and lead to higher biodiversity.

Keywords: agro-biodiversity, biodiversity, conservation, ecological network, farming system, grazing management, livestock production, restoration ecology soil productivity, steppe, Ukraine

Cover photo: courtesy of Mrs. L.P. Borovyk

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Summary

The Royal Netherlands Embassy in Kiev has requested a study to assess the opportunities and benefits of restoration of degraded steppe areas. There are millions of hectares of land in the Ukraine which either have been abandoned, or are farmed with a low land productivity due to severe land degradation. The transition from smallholder farming to large agro-industrial systems has resulted in abandoned settlements, and lack of viable perspectives for rural communities. The project therefore aims to bridge the gap between nature conservation and production agriculture, which should result in restoration of degraded lands towards more diverse steppe vegetations and new perspectives for rural areas.

The basic infrastructure for farming exists in Lugansk Oblast but further productive development requires new impulses and innovative approaches. Steppe can be used for profitable livestock production when it is integrated in a system of farms with arable land, situated near steppes within a good infrastructure of regional agricultural production.

The production potential in the region is determined by the combination of crop, soil and climate. It seems that two factors can potentially limit production. First, the relatively short growing season with possible hot and dry spells, which can be counteracted by the selection of appropriate crop varieties. Second, the risk of loss of soil fertility. It seems that even the use of these fertile soils is not without risk, and P and K deficiencies need to be considered. Also, mining of the organic top soil will increase the sensitivity to erosion. Without appropriate soil fertility management, yields will most likely remain low.

Steppe provide grazing land at low costs and extensive grazing is excellent for steppe and buffer zones. Steppe can be used for extensive grazing, hay making, and production of concentrates (barley, maize) which can be integrated in the farm plan.
Different breeds of cattle are used, mostly for milking or dual purpose. Most cattle are Holstein-Friesian (75%) and they are imported from Western Europe. Ukrainian breeds are Red Steppe and Grey Ukrainian. These breeds are adapted to the Ukrainian circumstances but their production is low and the growth rates will be normal or low. It will take at least 24 months to raise adult Grey Ukrainian cattle. For sheep, the breeds Romanov en Askania are used.

Based on the feed energy values of steppe grasses and the dry matter intake of cattle (without concentrates), grazing on steppe grass needs supplemental nutrition. Farmland can compensate for lack of nutrients by growing Sanfoin (onobrychis), Lucerne etcetera to supplement feed. Dairy cattle should graze close to the farm, because of the milking operation and the required supplemental nutrition, especially during spring and summer. Other cattle can graze further away, on the steppe.

Also for sheep, both lactating ewes and lambs, count that some parts of they year they should be kept close to the farm for supplemental nutrition. In other periods the nutritive value of steppe is sufficient and sheep can be kept on the steppe further from the farm.

Restoration of steppe is an important strategy to restore biodiversity. Ploughed and degraded lands can be restored through natural succession. Grazing is important to restore the steppes and its biodiversity because it will open up the sod, and it will result in seed dispersal of steppe plants. In particular herding of livestock does improve biodiversity. Also overgrazed land will recover if proper stocking rates are applied – but: it takes time.

The project revealed the very technical and complicated agro-steppe approach in Ukraine and Russia. Technical measures such as re-sowing of steppe are costly and result in disturbance, and an increase in ruderal species. Literature from the FAO suggests that leaving agricultural land with a management regime of light grazing the time for recovery may vary from six to fifteen year, depending on the local situation, land use history, frequency, depth of ploughing, the seedbank etc. Whenever possible extensive livestock grazing would be a preferred option to restore steppe.

Large ungulates were important shaping factors in the past and resulted in variation in microhabitats. Where possible, grazing with natural grazers should be re-introduced. In the absence of natural grazing, domestic animals can be useful to maintain steppe areas in good condition.

Finally, there are good opportunities for steppe restoration by connecting isolated steppe areas through the ECONET approach, in line with the Ukrainian policy. The development of ecological networks is of particular importance in such fragmented situations as we encounter in Lugansk Oblast, corridors are essential for migration of flora and fauna, and re-population of species that may have disappeared. An ecological network with core areas connected by corridors will facilitate the dispersal of species, and faster recovery of steppe.

Реюме

Посольство Королевства Нидерландов в Киеве предоставило финансирование на проведение совместных исследований группой ученых и практиков из Нидерландов и Украины по определению инвестиционной привлекательности создания в пределах степной зоны Украины ферм по экстенсивному животноводству. Развитие экстенсивного животноводства может быть использовано для восстановления степей на деградированных сельскохозяйственных землях и развития сельских территорий. Одна из целей проекта – определить инвестиционную привлекательность проектов по созданию фермерских хозяйств по разведению крупного рогатого скота с интегрированием вопросов восстановления и сохранения степей. Луганская область, Украина, была выбрана в качестве пилотной.

В Луганской области существует базовая сельскохозяйственная инфраструктура, необходимая для быстрого формирования фермерских хозяйств, но дальнейшее их продуктивное развитие требует новых импульсов и инновационных подходов. Степь может успешно сохраняться и восстанавливаться при условии ее использования для ведения прибыльного мясного животноводства и интеграции вопросов ее восстановления на деградированных и малопродуктивных землях и сохранения существующих участков в систему севооборота на полях. Производственный потенциал области определяется комбинацией возделываемых культур, почв и климата. Создается впечатление, что два фактора могут ограничить производство. Во-первых, относительно короткий период вегетации с высокой вероятностью наступления засухи, который можно нейтрализовать путем отбора соответствующих сортов сельскохозяйственных культур. Во-вторых, риск потери продуктивности. Несмотря на высокое плодородие почв, их использование не лишено определенного риска, необходимо учитывать недостаток фосфора и калия. Кроме того, обработка верхнего почвы повысит чувствительность почв к эрозии. Без надлежащего управления плодородием почв, продуктивность, скорее всего, будет оставаться низкой.

Степь дает возможность использования земель под пастбища при низких затратах на производство единицы продукции, а экстенсивный выпас отлично подходит для управления экосистемой степи с целью повышения уровня видов животных и растений, обитающих на ней. Степь может использоваться как в режиме экстенсивного выпаса, так и заготовки биомассы на сено или производства травяных концентратов. Для целей формирования прибыльных ферм рекомендуется использование различных пород крупного рогатого скота – это, в основном, молочные или двойного назначения - голштино-фризской породы (75%), которая импортируется из стран Западной Европы. Украинские породы: это красная степная и серая украинская. Эти породы приспособлены к украинским условиям, но они низкопродуктивны, и темпы роста будут лишь

средними или низкими. Необходимо минимум 24 месяца на то, чтобы вырастить взрослую особь серой украинской породы. В овцеводстве используются романовская и асканийская породы.

В случае, если кормовой рацион скота будет основан только на энергетической ценности степных трав и сухого травостоя, экономические показатели такой фермы будут недостаточно привлекательными для инвестирования. Кормовой рацион животных, выпасаемых на степных травах требует организации дополнительной подкормки за счет культур, выращиваемых на культивируемых полях, например, эспарцет, люцерна и пр.

Восстановление степи производится для целей (1) сохранения степного биоразнообразия и (2) для целей организации ведения экстенсивного животноводства. Финансирование деятельности по восстановлению степной растительности на деградированных сельскохозяйственных землях предоставляется в рамках реализации инвестиционных проектов. Технология восстановления степей включает в себя подсев степных трав и определенный режим выпаса с чередованием сезонов использования участка для заготовки сена и контролируемых палов. Технология восстановления степей использует существующее сельскохозяйственное оборудование и малозатратна (первоначальная инвестиция - до 120 евро на га).

Использование земель с формируемым степным растительным покровом для целей ведения экстенсивного мясного животноводства позволяет получить финансирование для проведения широкомасштабных работ, включить мероприятия по управлению восстанавливаемого степного пастбища в технологию ведения фермерского хозяйства (выпас, заготовка сена и пр.) и значительно ускорить процесс восстановления степного биоразнообразия на бывших сельскохозяйственных землях.

1 Introduction

1.1 Eurasian steppe project and BOCI project

Steppes are natural grasslands with a typical continental climate, 380-400 mm. rainfall, often on productive Chernozem soils. The steppes have a wide distribution from Hungary to Mongolia and China on the Eurasian continent, and similar vegetation types are found on other continents such as the tallgrass prairies in North America (Coupland, 1992).

Over the past century, the areal extent of steppic grasslands has shown a tremendous decline due to changes in land use. These were induced by political and economic changes in Eastern Europe. Naturally, the steppes would form some 240,000 km^2 or 40% of the territory of the Ukraine (UNECE, 1999). Due to conversion of natural grasslands, mainly for wheat production, as much as 90% of the former steppe habitat was lost. These extended cultivated areas were prone to erosion and degradation. With the loss of habitat, there was a concomitant decline in its accompanying flora and fauna. In addition to being monuments for biodiversity conservation, steppes provide many other services. Steppe provide other services such as production of biomass for livestock, protection against erosion, carbon sequestration, water conservation, etc. Tishkov (2009) provides an overview of steppe ecosystem services.

In the 1990s, the transition of land ownership from large kolkhozes to private ownership resulted in land abandonment. The EU-supported Eurasian Steppe project, which is executed by Euroconsult Mott-MacDonald, aims to restore degraded farmland to steppe and conserve virgin steppe in Lugansk Oblast and Rostov Oblast (fig. 1). Aim of the overall project is to improve rural livelihoods and develop new opportunities for regional development.
The region is one of the hotspots for biodiversity, with a unique flora and fauna adapted to semi-arid conditions.

The long-term objective of the Euroconsult Mott-MacDonald Eurasian Steppe project is: To contribute to the development of region-wide steppe ecosystem restoration and conservation, and its sustainable management, as part of a viable rural land use system. Immediate objectives are:

- To increase sustainable land use in steppe, wetland and forest-steppe ecosystems.
- To restore and use abandoned and degraded steppe lands, and improve management of privatised areas.
- To mainstream biodiversity concerns into rural land use policy at regional, national & local levels.
- To encourage transboundary cooperation between states in the management of steppe resources.

- To mobilise financing alternatives for sustainable management, conservation & restoration of steppes, including carbon sequestration and Greenhouse Gas funds, and other alternative sources.

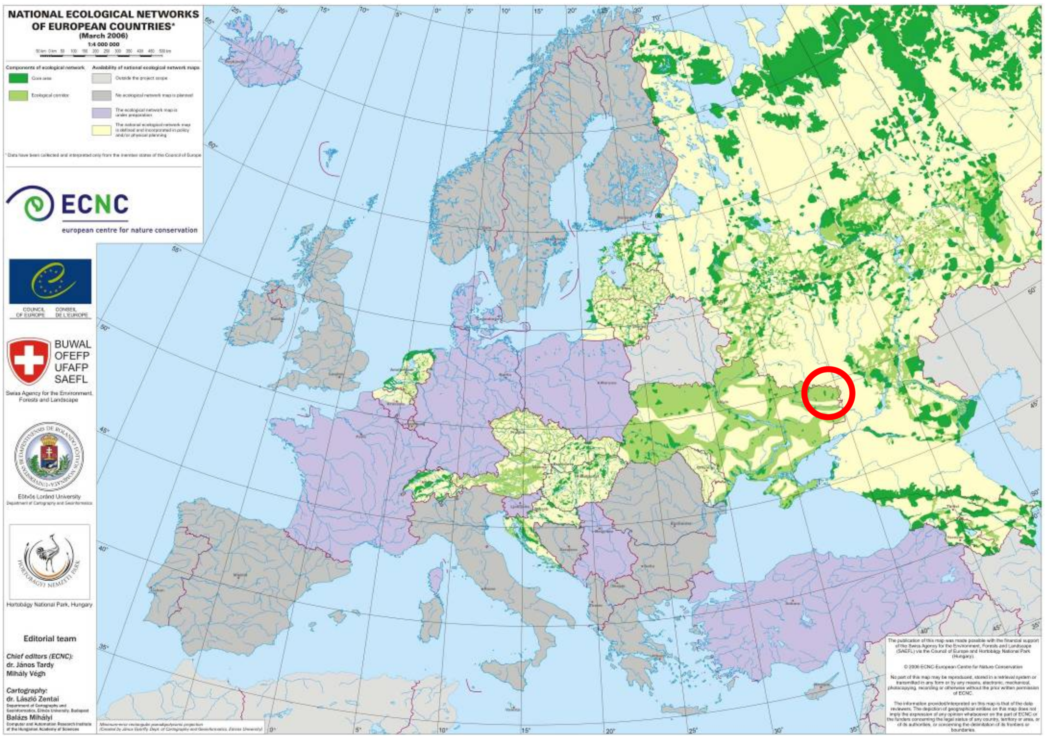

Figure 1: Ecological networks in Europe (www.seenet.info/images/maps). The project area (circle) is located in the border region of Ukraine: Lugansk Oblast (26,700 km2) .

The Netherlands Embassy has requested a study to assess the opportunities and benefits of restoration of degraded steppe areas. This project falls within the 'Policy support Cluster International' (BOCI) of the Ministry of Agriculture of the Netherlands.

There are millions of hectares of land in the Ukraine which either have been abandoned, or are farmed with a low land productivity due to severe land degradation. On the other hand, there are farms of thousands of hectares, which are managed at a large scale with intensive land use resulting in land degradation. In both cases biodiversity is very low. Farming expertise is limited, capacity is lacking to adjust management with the aim of developing or restoring productive systems and increase land productivity. The transition from smallholder farming to large agro-industrial systems has resulted in abandoned settlements, and lack of viable perspectives for rural communities. In nature conservation circles on the other hand, thus far the added value of extensive agricultural management for maintaining biodiversity is not appreciated.

The project therefore aims to bring in expertise to bridge the gap between nature conservation and production agriculture, which should result in restoration of degraded lands towards more diverse steppe vegetations. This requires reestablishment of former production functions, and/or development of new functions for steppe ecosystems, so that biodiversity conservation to some extent can go hand in hand with agro-productivity. To realise this, a transition from large-scale intensive farming towards more sustainable extensive systems with higher biodiversity is needed. Abandoned lands can be restored towards steppe with a higher biodiversity, where productivity is maintained through extensive management. To realize conservation objectives, it is aimed at integrating extensive agro-steppe management in nature reserve management, to sustain or increase biodiversity.

The BOCI project may add to the larger Eurasian Steppe Project, which may result in generating meaningful income for small rural households as well as the agro-industry, and an increase in biodiversity, both in agricultural and conservation areas.
Leading question for the project is:
How can we restore degraded (partly abandoned) agricultural lands, increase biodiversity and develop a more resilient ecosystem.

The following sub-questions can be defined:
- How can we restore the natural steppe vegetation on degraded lands;
- What grazing management (grazing pressure, grazing pattern) is required to sustain a productive steppe vegetation;
- How can biodiversity be increased, through integration of extensive farming in steppe management;
- Can extensive farming practices be integrated into nature conservation, aiming at maximum biodiversity and a sustainable steppe vegetation with production of marketable agricultural products which also generates income for agriculture.

The goal of this project is the restoration of degraded land and to attain more sustainable land use with a higher biodiversity. Innovative farming systems are proposed which are both economically and environmentally sustainable agricultural production systems. This will improve the livelihood of farmers and lead to higher biodiversity.

1.2 Methods

Through the Eurasian Steppe Project, local farmers and regional authorities are stimulated to restore the former steppe vegetation. Extensive grazing is promoted to maintain steppe habitat and demonstration plots were established. Protected Areas are currently being extended and management plans prepared. Steppe habitat (both virgin steppe and degraded steppe) has been mapped and flora and fauna surveys were carried out in 2008. These different activities formed the basis for this assessment.

From the 5-11th of April 2009 Lugansk oblast was visited by a team of Wageningen University and Research Centre: T. van der Sluis (Alterra, biodiversity & land use, team leader), J.M.J. Gosselink (Animal Sciences Group, veterinarian & livestock specialist), Prof. H. van Keulen (Plant Research International, farming systems) and

P.A. Slim (Alterra, botanist). The field visit was facilitated by Ruslan Markov (Mott MacDonald, Project coordinator Lugansk); transport was by car or 'marshrutka'.

An integrated approach is essential, since land use has different objectives, such as maximization of marketable agricultural output, or maximization of biodiversity which are partially conflicting. The multidisciplinary team took a holistic view of resources, resource use, productivity of the system, and biodiversity aspects. Data and literature was collected in preparation for the field visit.

Goal of the field visit was to see some of the remaining steppe areas in Lugansk oblast (see travel scheme, appendix 1) and meet local experts to discuss the management issues and development potential of steppe. Figure 2 shows the areas visited during the field week.

The vegetation in April was brown and dry after a severe and long winter period. This period was rather early in terms of the development of the vegetation but some spring flora of ruderal and trampled places was already in bloom.

Different aspects of land use were assessed, such as the possibilities for restoration of steppe vegetation on degraded lands, possible sustainable grazing management for steppe vegetation, suitable livestock breeds and its production, marketing and the role of grazing in conservation areas.

A second field visit was made by Pieter Slim with botanical experts in April and May. After visiting Ukraine the International Symposium on 'Steppes of Northern Eurasia' in Orenburg, Russia, was attended. For all these expeditions the help and contribution of local experts was essential.

Figure 2: Map showing the areas visited in Lugansk Oblast

Based on the field visit, the Wageningen experts collected additional information, either through accessible literature, requested data from local (Lugansk or Ukrainian) experts, or through experts from Wageningen or other universities. This data complemented the field observations.

Extensive discussions within the research team resulted in a kind of ‘communis opinio’ on steppe management, agricultural production and conservation.
In the process, Herman van Keulen became seriously ill; his tasks were taken over by Jan Verhagen from PRI, who finished the work in close consultation with Herman van Keulen.

This research was done with funding from the ‘Policy support Cluster International’ (BOCI) programme from the Ministry of Agriculture, the Netherlands.

We want to thank Mr. Meeuwes Brouwer and Mrs. Edith Oudt of the Royal Netherlands Embassy in Kiev for their support and advice.

We want to express our gratitude to all staff in the Ukraine, which assisted us in the collection of data and field visits. First of all the Team Leader of Euroconsult-MottMacDonald in Lugansk, Ruslan Markov. From the Lugansk Oblast we want to thank in particular the Governor Mr. Arapov. We appreciate the support from staff from the Lugansk Zapovydniki, Mrs. Sova, Mrs. and Mr. Borovyk and all other staff. Our gratitude also to Barbara Sudnik-Wójcikowska of the University of Warsaw, and Ivan Moysiyenko of Kherson State University and Mrs. Vakarenko for their assistance in the field work.

From Euroconsult-MottMacdonald we want to thank the staff that supported us in the preparations and facilitation of the work, in particular Rieks Bosch, Jelmer Buys and Nadiya Mischenko.

Steppe along the Derkul River

2 Lugansk Oblast, Ukraine

2.1 Geography

The fertile plains of the Ukraine are well known. The Ukraine with its highly developed agricultural sector was known as the 'breadbasket of Europe'. It generated more than a quarter of the total agricultural output of the Soviet Union.

The dominant soil is classified as Chernozem, a common soil on the cooler mid-latitude steppes of Eurasia. The main parent material is löss. Chernozems have a very dark mollic horizon (thick, brownish or blackish surface horizon with a significant accumulation of organic matter and high base saturation (ISRIC, 2009)). These are fertile soils and provided there is sufficient water, these soils are among the most productive in the world. However, given their parent material, these soil are erosion-prone and especially under intensive cultivation on steep slopes soil erosion and gullies are common features.

Besides physical degradation, the EEA (2003) reported contamination by pesticides as a common phenomenon in the Ukraine (more than 5 million ha) and more than 20% of the investigated agricultural lands in the Ukraine are polluted by DDT.

The climate is continental, with relative cold winters and dry hot summers with a more Mediterranean character in the south. Temperatures in the area of Lugansk are on average 22 °C in the summer and – 7 °C in the winter period. Precipitation levels are relatively low (450 – 500 mm annually), most rain falls during the April-September period.

2.2 Natural vegetation Lugansk Oblast

The natural vegetation is described in the standard publication of steppes of the world (Boonman & Mikhalev, 2005) and local publications (Lavrenko & Karamysheva, 1993).

On a European level the (potential) natural vegetation of Ukraine can be described along a northwest-southeast gradient predominantly determined by climatic factors. The following seven vegetation zones from north to south give a broad outline (Bohn *et al., 20*00). To give an indication for the geographical position, some cities are indicated.

1) **Mesophytic deciduous broad-leaved and mixed coniferous-broad-leaved forests > Acidophilous oak and mixed oak forests, poor in species** (*Quercus robur*[1], *Q. petraea*, *Pinus sylvestris*, *Betula pendula*, *B. pubescens* s.l., *Castanea sativa*): lowland to sub-montane types.
   Kyiv is situated more or less on the border of this and the following zone.
2) **Mesophytic deciduous broad-leaved and mixed coniferous-broad-leaved forests > Mixed oak-hornbeam forests** (*Carpinus betulus*, *Quercus robur*, *Q. petraea*, *Tilia cordata*, *T. tomentosa*, *Fraxinus excelsior*, *Fagus sylvatica*).
3) **Forest steppes** (meadow steppes or dry grasslands alternating with deciduous broad-leaved forests or xerophytic scrubs) > Subcontinental meadow steppes and dry grassland (*Festuca rupicola*, *F. valesiaca*, *Stipa tirsa*, *S. pennata* etc.) alternating with oak forests (*Quercus robur*) or scrub: lowland-colline types.
   Kharkiv (Charkov) is situated more or less between this and the following zone.
4) **True steppes > Herb-rich grass steppes** (*Stipa tirsa*, *S. pulcherrima*, *S. dasyphylla*, *S. zelesskii*, *Festuca valesiaca*): lowland-colline types.
5) **True steppes > Herb-grass steppes** (*Stipa ucrainica*, *S. zelesskii*, *S. anomala*, *S. lessingiana*, *Festuca valesiaca*): lowland-colline types.
   Donetsk is situated in this zone.
6) **True steppes > Grass steppes** (*Stipa ucrainica, S. lessingiana, Festuca valesiaca*).
   Odessa is situated in this zone.
7) **Desert steppes** (*Stipa lessingiana*, *S. sareptana*, *Festuca valesiaca*, *Artemisia* spp.).
   This zone is situated near the Black Sea and Crimea.

The 'Indicative map of the Pan-European Ecological Network (PEEN) for Central and Eastern Europe' shows that only patches of 'Steppic grassland (natural, semi-natural and cultivated grasslands)' are left in Ukraine (Bouwma *et al.,* 2002). The same situation exists also in North America: tallgrass prairie is there one of the most fragmented biomes and has been reduced to <5% of its original areal (Rosas *et al.,* 2008). Within the larger Eurasian Steppe project, the problem of fragmentation is being addressed through development of Ecological Networks (an der Sluis *et al.*, in press)

From the above mentioned seven vegetation zones, roughly 4) Herb-rich grass steppes, and 5) Herb-grass steppes form the (potential) natural vegetation in Lugansk oblast (Bohn *et al.,* 2000), focal point of our project.

From the Herb-rich grass steppes we find in Lugansk oblast the following types:

M1) **West and central Pontic herb-rich grass steppes** (*Stipa tirsa*, *S. lessingiana*, *Bromopsis riparia*) with *Stipa ucrainica*, *Paeonia tenuifolia*;

M2) **Central Pontic herb-rich grass steppes** (*Stipa tirsa*, *S. lessingiana*, *Bromopsis riparia*, *Helictotrichon schellianum*, *Anemone sylvestris*, *Lathyrus pannonicus*, *Echium russicum*) with *Stipa zelesskii*, *Caragana frutex*.

From the Herb-grass steppes we find in Lugansk oblast:

M5) **West and central Pontic herb-grass steppes** (*Stipa ucrainica*, *S. lessingiana*) with *Caragana mollis*;

[1] Nomenclature of scientific names follows the Ukrainian flora (Prokudin *et al.* 1987) and the Provisional checklist of vascular plants of Ukraine (Bulakh no year).

M6) **Central Pontic herb-grass steppes** (*Stipa lessingiana*, *S. capillata*, *Salvia nutans*, *S. nemorosa*, *Medicago romanica*) with *Calophaca wolgarica*, *Stipa zelesskii*, *Salvia stepposa*;

M8) **Pontic psammophytic herb-grass steppes** (*Stipa anomala*, *Agropyron* spp., *Festuca beckeri*, *Koeleria sabuletorum*, *Leymus racemosus*, *Helichrysum arenarium*, *Euphorbia seguieriana*) with *Artemisia marschalliana*.

Also within the Oblast there is a northwest-southeast gradient in steppe vegetation. In the northwest part of Lugansk oblast the M1 and M2 types of the 'Herb-rich grass steppes' dominate, and in the southeast the M5 and M6 types of the 'Herb-grass steppes' dominate. Most steppe reserves are situated in the latter.

The remaining steppe in Lugansk Oblast is fragmented. The steppe areas on the plains, the watershed boundaries, have mostly been ploughed. Fragments of steppe are left in gullies and slopes of river valleys (Figure 4).

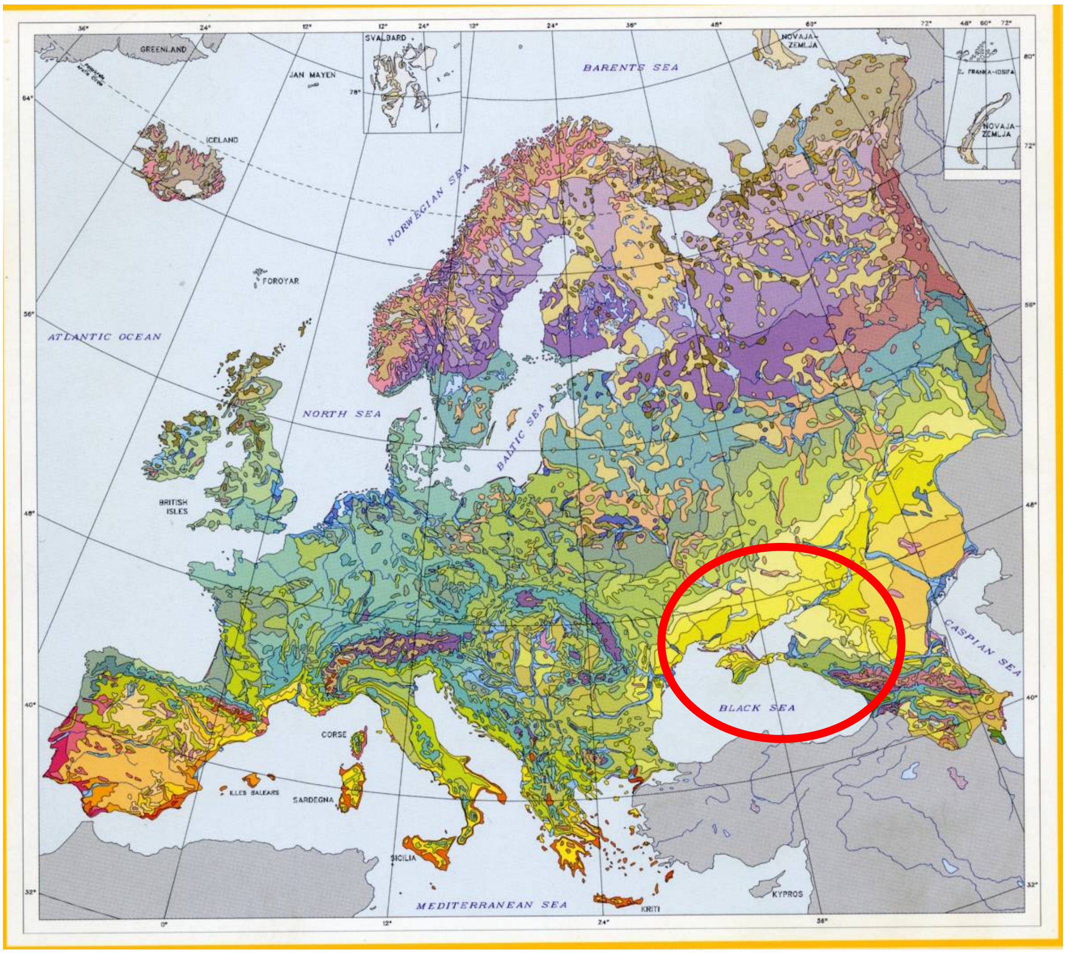

Figure 3: Reduced Map of the Natural Vegetation of Europe, scale 1 : 10 000 000 (Bohn et al., 2000). In Central and East Europe: the four yellow colours are Steppes (see type 4-7 below). Bordering left: light green colour are Forest steppes (type 3 below). Bordering right: light brown colour are deserts.

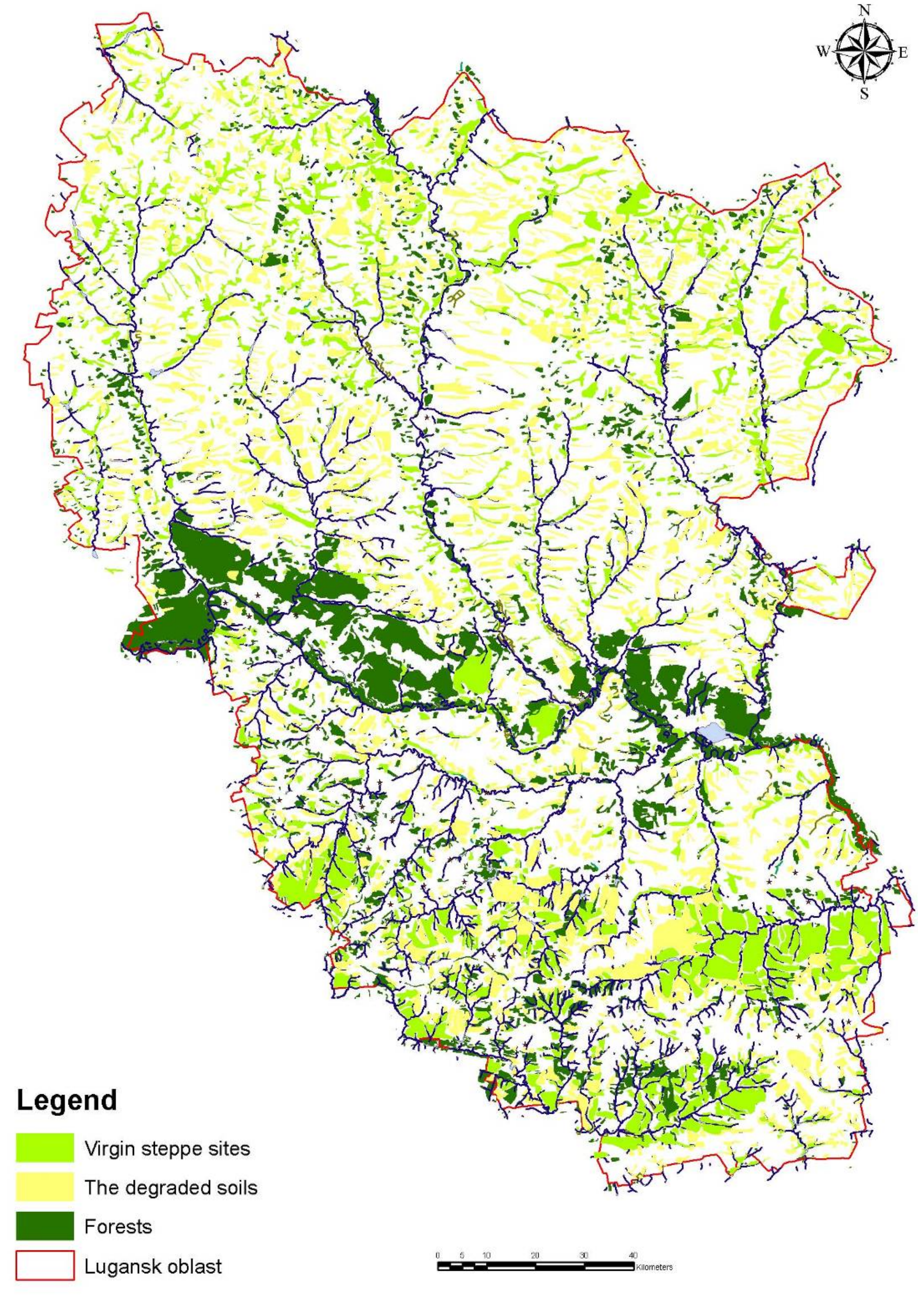

Figure 4: The remaining steppe habitat in Lugansk Oblast, based on satellite imagery and field investigations (Djos, 2009, mapping by A. Axem).

2.3 Fauna

Steppe ecosystems are characterized by their own typical fauna, that is adapted to the vegetation type and dry climates. Some Large herbivores found on steppe are Roedeer (*Capreolus capreolus*), and Saiga antelope (*Saiga tartaricus*). Roedeer can be found near forested areas or dry valleys with forest (balki) which they require for protection. The Saiga has been extinct for many decades.

Distribution maps of mammals in the Ukraine are available (not all are necessarily steppe species): *Talpa europaea, Crocidura leucodon, Lepus europaeus, Micromys minutus, Glis glis, Cricetus cricetus, Microtus oeconomus, Vulpes vulpes, Mustela nivalis, Capreolus capreolus, Citellus suslicus, Marmota bobak, Spalax microphalmus, Allactada jaculus, Mustela eversmanni, Spalax polonicus, Citellus citellus, Erinaceus europaeus, Rhinolopus hipposideros, Citellus pygmaeus, Sicista subtilis, Apodemus flavcollis, Cricetulus migratorius, Ellobius talpinus, Ursus arctos, Mustella lutreola, Meles meles, Felis lynx, Crocidura suaveolens* (Zagorodniuk, 2009, http://www.ulrmc.org.ua/services/ecoreg/start_pm.html).

The following species are the species of main conservation concern (Both and De Jong, 2008):

- Great Jerboa (*Allactaga major*)
- Russian polecat (*Mustela eversmanni*)
- Isabelline Wheatear (*Oenanthe isabellina*)
- Short-toed Lark (*Calandrella cinerea*)
- Short-eared Owl (*Asio flammeus*)
- Large whip snake (*Coluber jugularis (caspius)*)
- Steppe viper / Ursini's viper (*Vipera ursinii*)
- Predatory bush cricket (*Saga pedo*)
- *Carabus hungaricus scythus Motsch*

2.4 Ecology of steppe

Steppe ecosystems are primarily formed by extreme abiotic conditions, a dry climate which inhibits formation of forest. Drought and extreme temperatures play a role here, however, also grazing can influence vegetation development. The shaping factors for the abiotic system are mostly climate, and occasional fires. The biotic conditions are defined by the fauna, in particular grazing animals and animals which form burrows.

'Fire, drought, and bison (Bison bison) grazing were major forces shaping tallgrass prairie' (Rosas et al., 2008). These driving factors are also very important in the steppe biome. Grasses and grazing coevolved during a very long period, belong together, and 'the 'foliage is the fruit' hypothesis, suggest[ing] foliage may attract dispersal agents in small-fruited herbaceous plants, such as grasses' (Rosas et al., 2008).

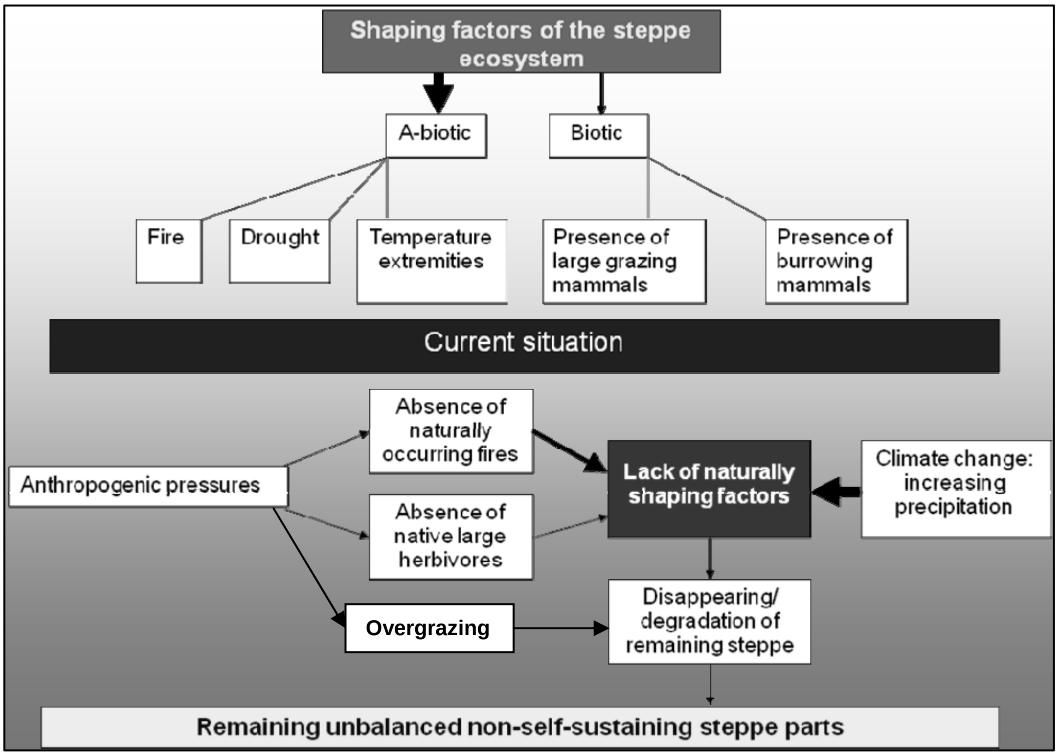

Figure 5: Factors which determine the steppe ecosystem (after Both and the Jong, 2008)

Lycaena sp. on Salvia nutans

3 Description of agriculture and bottlenecks for development of the sector

3.1 Agricultural production

Many agricultural areas were abandoned in the 1990s, due to the political changes and crisis that the agricultural sector went through, but also the change in land ownership: the kolchoz or community farming system was abandoned. The vast parcels became fragmented over the households of the kolkhoz, which resulted in un-economical units, which are usually not formally registered. Land registration is inhibiting easy transfer of user rights, registration with the cadastre is often too costly for small farmers. The better farms are continued by private entrepreneurs who rent the land from the communal owners for a nominal fee, but in some areas these entrepreneurs were not forthcoming. In these cases the land would sometimes be farmed by small farmers which farm on a few hectares with a few head of sheep and cattle, or the lands are abandoned.

Currently, large parts of the area are degraded and abandoned, but large farms (thousands of hectares) can still be found. Before 1990, the main targets for the dairy farmers was to produce for the urban centers in the Soviet Union. Farms of 1000 – 1500 head of cattle with production levels up to 4000 kg milk/lactation were important in achieving the set targets.

This system collapsed in the '90s, as the market changed and the system became more sensitive to price fluctuations. With prices in summer being twice as high as in winter, many large-scale specialized farms disappeared. Currently, a limited number of enterprises with 300 - 500 head of cattle are still operational, these farms form about one third of the total cattle population.

A large number of smallholders with 1-5 head of cattle represent 70% of the total cattle population. The milk produced by these smallholders is of low quality, which is further deteriorated by the poor collection and transport system.
The cattle are fed sunflower cake, wheat, barley, grain maize, which is produced on-farm and silage and hay, some of which originates from outside the region.

Most of the larger enterprises that quit dairy farming in recent years have reverted to arable farming: sunflower, wheat, grain maize, barley. The recent (2009) low milk prices add to the economic stress for dairy farmers and will most likely result in a further decline in number of dairy farms.

Despite the decline in numbers, dairy is still among the leading agro-business industries in the country, and the milk processing industry has the largest share, 18%, of the aggregate volume of the food and processing industry. This is compared to 13% for the meat processing industry and 6.5% for confectioneries. Nevertheless, production capacities for Ukrainian milk processors are barely utilized. The capacity exceeds 18.5 Tg [2] , though the industry processed only 4.2 Tg of raw milk in 2000-2004 and 5.2 Tg in 2005, according to official data. Capacities were utilised by only 25-35%, depending on the output (National Exhibition of Ukraine in the USA, 2006).

During the Soviet era, milk production in Ukraine was over 20 Tg (National Exhibition, 2006); currently, levels have stabilized around 12 - 13 Tg (see Table 1).

Table 1: Cow milk production (Teragram Tg) in the Ukraine

Year	1995	2000	2005	2007
Production (tons)	17,1	12,4	13,4	12,0

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The situation for meat production is not much different, the share of livestock and poultry production has dropped in relation to gross agricultural product. In 1990, as part of the USSR, the sector had a 29.0% share in gross agricultural produce in Ukraine, and dropped to 21.3% by the mid-1990s. In 2004, meat production contributed only 16.2% to the gross product of Ukraine's agriculture. According to statistics, the profitability of livestock and poultry raising has declined substantially since independence. For beef, it declined from 20.6% in 1990 to -19.8% in 1995 and to -33.8% in 2004 (National Exhibition of Ukraine in the USA, 2006).

The majority of livestock and poultry are raised on family farms, and not on commercial farms. In 1990, 85.6% of cattle stock was concentrated on large agricultural enterprises and 14.7% on family farms, by 2004 this structure had changed dramatically with 38.7% on large commercial farms and 61.3 on family farms (National Exhibition of Ukraine in the USA, 2006; FAO, 2001).

Table 2: Meat Production in the Ukraine (Tg)

Year	1995	2000	2005	2007
Beef	1.22	0.75	0.56	0.55
Chicken meat	0.24	0.19	0.50	0.69

FAOSTAT | © FAO Statistics Division 2009 | 14 July 2009

The trend is a reduction in livestock and expansion of the poultry population. In comparison to the beginning of 2004, in early 2005 all categories of farms reduced cattle population – by 9% (including cows – by 7.4%, sheep and goats – by 8.3%). At the same time, the population of pigs increased by 9%, and the poultry population was up by 5.2%.

It seems that currently animal husbandry in Ukraine is less successful than arable farming. Cattle numbers are increasing on private household farms, which typically have two to three head of cattle per farm, large industrial farms are shifting away from cattle toward crop production, so total cattle numbers continue to decrease (Tarassevych, 2004).

[2] Tg = Teragram = 10^{12} g

In general, mechanization and technical capacities of Ukraine's agricultural industry are poor. A major problem is agricultural machinery and fuels. The rate of equipment outdate is 10 times faster than the renewal tempos.

Given the history and the country's significant agricultural potential, the Ukrainian authorities are trying to find new ways for economic development, based on agriculture. The idea is that agriculture could boost the country's role as an international exporter, and that Ukrainian agricultural commodities will have a significant impact on global markets. The potential is clear, given the historical records, but poor performance, mainly related to sub-optimal management and poor technologies, hamper the development of the sector. Extension is lacking; sometimes this role is taken up by the local veterinarian (paid by the producers). During regular meetings with producers, the veterinarian records problems and acts as liaison with the specialists in the university. However, lack of skilled extension personnel hampers further efficient and effective communication between specialist (scientists) and the farming community, and thus adoption of new and/or improved technologies by farmers.

The transition from large enterprises to smallholder farmers changed the farming landscape dramatically. Smallholders use available natural pastures and use very few external inputs. Pasture improvement, re-seeding and/or fertilization hardly take place, resulting in production of small quantities of low-quality feed, overgrazing and land degradation.

The breeding and genetic improvements do not have a high priority. Dairy farming is hardly competitive and beef production might be able to compete, but it is unclear at which scale. Major bottlenecks are related to management and available technologies, including poor collection and transport systems needed for inputs such as fertilizers. The transition of large enterprises from animal husbandry to arable farming is a clear indicator for the relatively weak position of the dairy and meat sectors. Poor land management in arable systems will, however, also inevitably lead to land degradation and loss of production capacity. It is unlikely that the current extension service and distribution channels are effective enough to provide the necessary information and inputs to farmers. Also the disconnect of research and farmers hampers an efficient flow of information and technologies. Investments are needed to renovate these services.

For smallholders, the broadening of functions towards nature and landscape services may provide opportunities, but so far no clear policies or financial mechanisms to support this are present.

3.2 Production potential

The production potential in the region is determined by the combination crop, soil and climate. In this section we will try to assess the production potential of grass. Because experimental data are lacking, we will use rules of thumbs and indicator values. The analysis aims at identifying the production-limiting factor. This is done via a stepwise approach, in which first we will see whether the temperatures allow for a growing season, followed by water availability and lastly soil fertility is addressed. The production capacity based on each of these factors is calculated under the assumption that all other factors are not limiting production.

3.2.1 Temperature

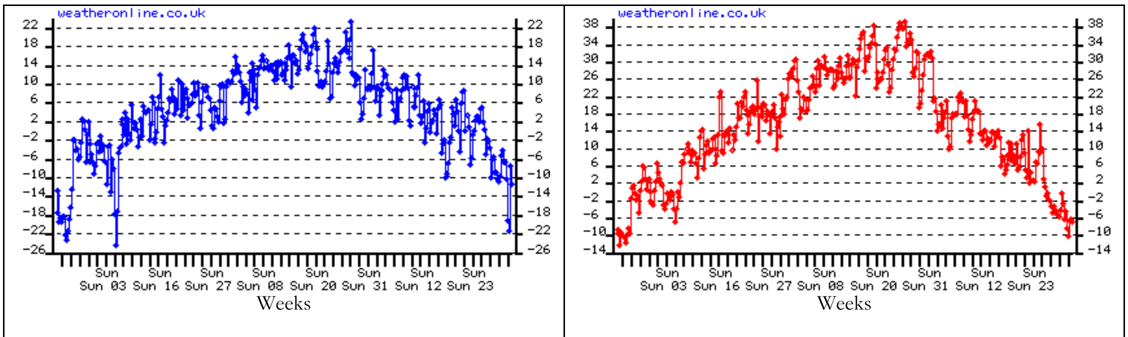
The length of the growing season, the period when crops can be grown, is partly set by the ambient temperature. The length of the growing season is an important factor determining total production. Indeed, a longer growing season allows for more productive days.

The phenological development rate of crops is positively correlated to temperature. Below a base temperature the crop does not develop, above a maximum threshold temperature development halts. In fact, higher temperatures accelerate crop phenological development and result in lower yields.

In this section we are not dealing with phenology (i.e. the order and rate at which the vegetative and reproductive organs appear), we only look at whether ambient temperatures allow for a long enough growing period. Between the base and the maximum temperature the crop will grow (i.e. increase in volume and/or weight), in the optimum range without limitation.

We assume plant growth to proceed non-limited in the temperature range 10 – 35° C, the baseline to be 5 °C and above 40° C growth is assumed to come to a halt. Of course these thresholds are species-specific. The values will be used to estimate the length of the growing season (Schapendonk *et al.* , 1987).

Both minimum and maximum daily temperature data for 2008 for Lugansk were taken from the weatheronline.co.uk web site (Figure). Because we do not have the numbers we will use these graphs to estimate the length of the growing season.



Min. Temperature °C Jan 02 2008 - Dec 31 2008 | Max temperature °C Jan 02 2008 - Dec 31 2008

Figure 6: Minimum and maximum temperatures for Lugansk

From the minimum temperature graph we estimate the growing season to be from week 15 till 35. In this period, temperatures are in the optimal range. High temperatures (>35° C) during the growing season could reduce growth rates for a short period. A growing season of 20 weeks or about 140 days is short, but with a growth rate of 200 kg per ha per day, a total biomass production of 28 000 kg per ha can be achieved. For wheat, with a harvest index of 0.4 and a fraction 0.2 of belowground biomass, this would still mean a grain production of about 9000 kg per ha.

So, although the growing period is short, it does not explain the low production levels.

3.2.2 Water

To determine whether water is limiting, we have to establish two things: the amount available and the conversion factors of water to dry matter. In this study, we assume that all production is rainfed, i.e. no irrigation is applied. From the meteo office we know that the average rainfall during the growing season is 380 mm. When assuming that only 50% of this water is transpired by the crop (this is relatively low) and the remainder is lost via runoff, percolation to the groundwater and evaporation, 190 mm is used by the crop, which is 1 900 000 liter per ha per year. Assuming a requirement of 250 liters for each kg dry matter produced (range 150 – 350) we arrive at an annual production of 7600 kg DM per ha. For wheat, this would mean a grain production of about 2500 kg per ha, which is also substantially higher than current production levels.

Water is not the limiting factor in these systems, but when aiming for higher yields irrigation will be required.

3.2.3 Nitrogen

Under natural conditions, soil organic matter is the provider of nitrogen which is stored in the soil organic matter (SOM). The higher the SOM content and the deeper the layer with SOM, the more N is available for crop production. The soils in the region are dark organic soils with no limits for root development in the soil profile.

We assume a rooting depth of 0.8 m (grasses can have deeper root systems, but mostly 80% of the roots is within this depth) and an organic matter content of 5% (Chernozems can have values up to 10%). With these values we have a soil body of 8000 m3 per hectare (0.8 m * 10000 m2); a bulk density of 1200 kg per m3 results in a 9 600 000 kg soil.

A SOM content of 5% gives 480 000 kg SOM. To calculate nitrogen via a C/N ratio, we need to establish the total amount of C in the soil. The conversion factor from SOM to Soil Organic Carbon is 0.58 (Driessen, 1986), this conversion factor may differ per soil type. So, now we have a total of 278 400 kg C per ha, which, with a C/N ratio of 10 gives 27840 kg N per ha present in the root zone.

The N available to the crop is determined by the oxidation or mineralization rate of the organic matter. For the Netherlands, a rate of 2% per year is commonly used, for our case study we assume a lower rate and take 1% (Kortleven, 1963; Yang, 1996). So, only 278.4 kg of nitrogen per ha is available per year. Mineralization takes place during the warm summer period and the resulting inorganic nitrogen is available for plant production. For grass, the conversion of applied N to dry matter production is set to 30 kg DM per kg N (Table 5. Van Der Meer *et al.* , 1987). This is DM of the harvested product, so with 278.4 kg available N, a production of 8362 kg DM per ha per year is calculated. An annual production of 8 ton DM grass per ha is high compared to current levels.

If we look at wheat production, a value of 55 kg grain DM per kg N is used (Van Keulen and Van Heemst, 1982); with the same amount of N we could theoretically achieve grain yields of around 15 ton per hectare.

We conclude that nitrogen is not the limiting factor in these systems.

Besides nitrogen, other nutrients, notably the macro-nutrients phosphorus (P) and potassium (K), are also crucial for crop growth.

Even in the fertile black earth (chernozem) soils with relatively high contents of P, phosphorus can, because not all P is available, be the production-limiting factor. According to the results of the sixth agrochemical survey of Ukrainian soils, most have a low and average content of available phosphorus, these levels are insufficient to produce high yields (Table 3). (FAO, 2005).

Table 3: Content of available phosphorus in Ukrainian soils

Zone Distribution of soils by phosphate content, percent				
	Low	Average	Fairly high	High
Polissya	17.9	26.6	24.8	30.7
Lisosteppe	5.0	50.9	27.4	16.1
Steppe	7.9	44.8	29.5	17.8
Total Ukraine	**8.3**	**44.5**	**27.9**	**19.4**

Source: Sixth agrochemical survey, 1991-1995 (FAO, 2005)

The steppe soils in the Ukraine have relatively high levels of K, but the level seems to be declining (Tabel 4).

Table 4: Exchangeable potassium content Ukraine soils, by region

Years Content of K2O, mg/100 g of soil				
	Steppe	**Forest and steppe regions**	**Wood-lands**	**Ukraine**
1986–1990	13.7	10.6	10.3	11.3
1991–1995	11.6	10.5	11.4	11.1

Source: Sixth agrochemical survey, 1991-1995 (FAO, 2005)

In general, the chernozems of the Ukraine are among the most fertile soils in the world. From the available information it seems that P is limiting production and K may become an issue in the future. Without N fertilizer, soil organic matter will be depleted over time, resulting in low fertility and a higher sensitivity to wind erosion.

3.2.4 Conclusion

It seems that two factors can potentially limit production. First, the relatively short growing season with possible hot and dry spells, will most likely limit productivity. A management option that could counteract this and enhance production levels is the selection of appropriate crop varieties.

Second, the danger of loss of soil fertility. It seems that even the use of these fertile soils is not without risk, and P and K deficiencies need to be considered. Also, mining of the organic top soil will increase the sensitivity to erosion. Without appropriate soil fertility management, yields will most likely remain low.

Grass sampling by Jules Gosselink and Pieter Slim

4 Livestock breeding

Before 1990 (Perestrojka), livestock production was an important economic activity in Lugansk Oblast, with more than 300.000 head of cattle, especially dairy cattle. The Kolchozes and Sovchozes had on average herds of 1000 - 1500 cattle. There was a good infrastructure for agriculture and livestock production (i.e. food and knowledge). Nowadays there are 80.000 head of cattle in the Oblast and the number of sheep is much lower than before 1990. Some 30% of the cattle are found on relatively large farms with 200 to 500 head of cattle, mostly dairy cattle or dual purpose (milk and beef) cattle. Some big dairy farms with more than 1000 head of cattle are being developed. Currently, some 70% of the cattle can be found on small farms (households) in small numbers of 2 to 3 head per household. There is a tendency of marginalisation of small farms, and it is expected that in due time, only medium and large specialised holdings will remain.

Different breeds of cattle are used, mostly for milking or dual purpose. Most cattle are Holstein-Friesian (75%) and they are imported from Western Europe. Other breeds from abroad are Aberdeen-Angus and Simmentaler. Ukrainean breeds are Red Steppe and Grey Ukrainean. These breeds are adapted to the Ukrainean circumstances and can be used for grazing and milk- and beef production on steppes. However, on steppes their production will be low and the growth rates will be normal or low. It will take at least 24 months to raise adult Grey Ukrainean catle (Table 5). For sheep, the breeds Romanov en Askania are used: lambs are sold after 1 year and wool is also collected for income.

4.1 Climate and feed

The growing season in Lugansk Oblast starts in March when the temperature is higher than 5 °C, until July, when the climate gets too hot (21 to 40 °C). In autumn, little growth of grass is expected till December and in winter the climate is too cold (-7 till –35 °C). The production on the steppes is highest in May and June. Each year the grass production on the steppe is 1.5 to 2 ton dry matter per ha, mostly of the species Festuca sulcata, Stipa capillata and Koeleria cristata. The growing season of the steppe can be divided in 4 periods:

1. Spring, from March till July (when temperature is higher than 5 °C), is the best period for the growth of grass. In this period the steppe will be most profitable for grazing animals with a high demand for nutrients: ewes with lambs, cows with calves, lactating cows with a high milk production.
2. Summer, from July till September, the climate is hot and dry. There is no growth of grass and steppe becomes stem-cured hay.
3. Autumn, from September till November or December, is also dry and little growth of grass can be observed. The animals can be kept outside.
4. Winter, December till April, is wet and too cold for grass growth and animals are kept in the stables.

Table 5: The dynamic live mass of Grey Ukraine beef cattle breed (kg)

Level of selection	6 month	7 month	8 month	9 month	10 month	11 month	12 month	13 month	14 month	15 month	16 month	17 month	18 month	19 month	20 month	21 month	22 month	23 month	24 month
Sex: bulls																			
Elita-record	195	215	245	270	295	320	345	365	390	410	425	440	460	480	500	520	540	570	600
Elita	185	205	230	255	275	300	325	345	370	390	405	420	440	460	480	500	520	550	570
1 klass	170	195	220	245	265	290	310	330	350	375	390	405	420	440	460	480	500	520	550
2 klass	150	170	190	210	225	245	265	280	300	320	330	340	360	385	410	430	460	480	500
Sex: halfs																			
Elita-record	155	175	200	220	235	255	270	285	295	310	325	340	350	360	370	380	390	400	420
Elita	150	170	195	215	230	245	260	275	290	305	320	335	345	355	365	375	385	395	410
1 klass	145	165	190	210	225	240	255	270	285	300	315	330	340	350	360	370	380	390	400
2 klass	125	140	155	175	185	200	215	225	235	250	260	270	280	290	300	310	320	330	345

Most cropland in the Oblast is used for arable cropping, of which the products can be used as concentrates for cattle: wheat, barley, oats, corn and sunflower cakes. Also forages are produced, like straw from wheat or barley, silage from maize or rye and hay from (degraded) steppes or cropland. For haymaking, sometimes sainfoin (Onobrychis sp.) or lucerne (Medicago sativa ssp. Sativa) are sown in spring for additional protein. Hay (dry or semidry) is harvested from the field after mowing or directly from the plant stem.

4.2 Livestock production using steppes

Early April 2009 3 samples of steppe grasses were taken from near Provalje steppe: one sample each of Festuca sulcata, Stipa capillata and Koeleria cristata. The grasses were short and green and the result of little growth since it was shortly after winter. The feeding value of this grass was determined with NIRS (Near InfraRed Spectroscopy) and crude protein and crude ash were determined chemically in a Dutch laboratory (Table 6).

Table 6: Feeding value (g/kg dry matter) of 3 samples of steppe grasses from the 7th of April 2009, analysed in a Dutch laboratory

Grass species	Festuca sulcata	Koeleria cristata	Stipa capillata
Dry matter (DM, g/kg)	286	248	453
Crude protein	217	166	221
Crude Ash	80	111	56
VEM *	823	826	701
Digestible organic matter	635	645	557
Crude Fibre	237	261	265
NDF**	565	546	686

* VEM = Dutch unit for feed energy and the values in Joules can be found in Table 3
** Neutral Detergent Fibre

Festuca and Koeleria had already grown more than Stipa. Stipa had higher dry matter content and NDF values and lower energy content and digestibility. Festuca and Stipa had high values of crude protein, but these will decrease after a few more weeks of growth in spring. Because of limited data and the relatively high protein content of the grasses, the prediction of animal production based on steppe grass is done using energy values. To predict the energy value during the growing seasons also the data from Table 2 is used, with assumed energy values for eastern Europe are used (personal communication, P. Snijders, Wageningen UR).

The feeding values will be higher during spring, lower during summer, and in autumn probably between the values from summer and spring, depending on the length of the dry spell. The first growth of grass has reasonably high energy values, even natural (not fertilized) grass. On the basis of the limited data, the following energy values of steppe grass for grazing are assumed during 3 growing seasons:

- Spring: 900 VEM
- Summer: 700 VEM
- Autumn: 800 VEM

In Table 7, the energy values of VEM (Dutch unit for feed energy) are described in Joules.

Table 7: Assumed energy value (per kg dry mater) of different forages in Eastern Europe (personal communication, P. Snijders, Wageningen UR)

	Metabolic energy (MJ)	Net energy (NEL, MJ)	VEM
Very old hay	7.6	4.15	600
Low quality hay or silage	8.7	4.85	700
Medium/good quality forage	9.8	5.45	800
High quality maize and grass silage	10.9	6.3	900
Young grass	12.0		1000

* VEM = Dutch unit for feed energy

Two samples of hay from Lugansk (summer) with good quality were analyzed and they had VEM-values between 750 and 800 but low crude protein content (Table 4b).

Table 8: Feeding value (g/kg dry matter) of 2 samples of hay from steppe grasses from Lugansk Oblast, defined in a Dutch laboratory

Grass species	*145*	*146*
Dry matter (DM, g/kg)	897	900
Crude protein	84	72
Crude Ash	53	60
VEM *	756	786
Digestible organic matter	622	638
Crude Fibre	371	340
NDF**	628	658

* VEM = Dutch unit for feed energy and the values in Joules can be found in Table 3

** Neutral Detergent Fibre

4.3 Dry matter intake cattle and sheep

The dry matter intake (DMI) on steppe for growing cattle is between 1.5 and 3.0 kg DM per 100 kg of live weight (LW) and decreases with increasing age and with lower quality of feed (CVB, 2007). DMI is estimated for growing animals grazing on steppes and with typical low growth rates (Table 9).

Table 9: DMI (kg DM per day) estimated for growing cattle and dairy cows grazing on steppe (CVB, 2007)

Live weight	Growth, gram per day	Spring	Summer	Autumn
200 kg	850	4.5	3.5	4
300 kg	700	6.0	5.0	5.5
400 kg	625	7.0	6.0	6.5
500 kg	500	8.0	6.8	7.5
Dairy cows*		9.5	8.1	8.8

* For dairy cows, DMI depends on feed quality and production level. In Lugansk Oblast the milk production on farms is 2800 kg milk per year. On the level of 3000 kg milk per year the feed intake per season for grazing animals on steppes without concentrates (personal communication, P. Snijders from Wageningen UR) are estimated.

Table 10: DMI (kg DM per day) estimated for growing lambs and ewes with lambs grazing on steppes (CVB, 2007)

Live weight	Range	Spring	Summer	Autumn
Growing lambs				
20 kg	0.5 – 0.9	0.8	0.5	0.7
30 kg	0.8 – 1.3	1.2	0.8	1.0
40 kg	1.2 – 1.8	1.7	1.2	1.5
50 kg	1.4 – 2.0	1.9	1.4	1.7
Ewes with lambs				
First 2.5 months of gestation	0.9 – 1.5	1.4	0.9	1.2
Last 2 months of gestation	1.1 – 1.6	1.5	1.1	1.3
Lactating ewes, with 2 lambs				
- first month	2.5 – 3.3	3.1	2.5	2.8
- second month	2.3 – 3.0	2.8	2.3	2.6
- third month	1.9 – 2.5	2.3	1.9	2.1

4.4 Stocking rates

The stocking rates of cattle and sheep on steppes depend on supplemental nutrition. Based on grass production of 1.5 to 2 ton dry matter per hectare per year and the data from Tables 3 and 4, the stocking rate on steppe for dairy cows can be between 180 and 220 head and for sheep (50 kg live weight) between 750 and 1400 head per hectare for one day per year. This rate depends on the seasons: higher in spring and lower in autumn.

This figure (180-220, or 750-1400) can be used to calculate different stocking rates, e.g. wit a 10 ha. paddock and a grazing period of 18 days, a herd of 100 cattle would be permitted. For pastoral systems, herding by a herdsman, care should be taken not to exceed this threshold value in number of grazing days, e.g. with 20 head of cattle an area should not be grazed more than 10 days a year.

Very important is the observance of the winter rest, which assumes that no grazing takes place between November and the 15th of May (Buys, pers. comm).

4.5 Livestock production value

Based on the feeding energy values of steppe grasses and the dry matter intake of cattle, the intake of energy from steppes (without concentrates) can be calculated (Table 9).

In the first year, growing cattle at low growth rate, grazing on steppe grass need supplemental nutrition. In the second year (from April onwards), these animals have enough nutrition in spring, but supplemental nutrition in summer and autumn is necessary. This scheme would fit with the growth rates of Grey Ukrainean in 24 months (Table 5).

Dairy cattle should graze close to the farm, because of the milking operation and the required supplemental nutrition, especially during spring and summer.
In summer (July and August), growing lambs should be kept close to farm because they need supplemental nutrition. In autumn they don't need supplemental nutrition (Table 11) and can be kept on the steppe further from the farm.

The nutritive value of steppe in spring is sufficient for ewes without lambs (inclusive gestation) (Table 12). Lactating ewes find enough nutrition on the steppe in spring, but they need additional nutrition in summer (Table 12).

Table 11: Intake of energy (VEM per day) for grazing cattle on steppes and requirement of energy (VEM per day) for grazing cattle (CVB, 2007), assuming that calves are born in March or April

Live weight	Requirement	Intake of energy from steppe		
(birth calf in March /April, 50 kg)		Spring	Summer	Autumn
200 kg (April - September, 1st year)	4000	4050	2450	3200
300 kg (October - February, 1st year)	5200	5400	3500	4400
400 kg (March - July, 2nd year)	5900	6300	4200	5200
500 kg (August - January or later, 2nd or 3rd year:	7400	7200	4760	6000
Lactating dairy cows		8550	5670	7040
Maintenance (M)	5323			
Milk production*				
15 kg (incl. M) (April - June)	12100	8550		
10 kg (incl. M) (July - August)	9800		5670	
5 kg (incl. M) (September – November)	7540			7040

* milk with 4% fat and 3.3% protein; VEM = Dutch unit of feed energy for production of dairy cattle

Table 12: Requirement and intake of energy (VEM per day) estimated for growing lambs and ewes with lambs grazing on steppes (CVB, 2007), assuming that the lambs are born in spring

Live weight	Requirement*	Intake of energy from steppe		
		Spring	Summer	Autumn
Lambs (growth 200 grams per day)				
20 kg (July)	646	720	350	560
30 kg (August)	874	1080	560	800
40 kg (September - October)	1083	1530	840	1200
50 kg (November - December)	1292	1710	980	1360
Ewes (50 kg) with lambs				
Maintenance (August —December)	536		630	960
First 2.5 months of gestation (January - February)	542	1260	630	960
Last 2 months of gestation (March - April)	960	1350	770	1040
Ewes with 2 suckling lambs				
- first month (April - May)	2337	2790	1750	2240
- second month (May - June)	2081	2520	1610	2080
- third month (June - July)	1634	2070	1330	1680

* Requirements are estimated from CVB tables: VEM = 0.95 * VEVI; VEM = Dutch unit of feed energy for production of dairy cattle, VEVI = Dutch unit of feed energy for meat production of beef cattle

5 Steppe degradation and restoration

5.1 Introduction

The original major steppe biome in Ukraine has for the most part been converted into arable land. It is estimated that under a natural conditions some 240,000 km2 or 40% of the territory of the Ukraine would consist of steppe (UNECE, 1999). Of this area, at least 82-90 % would be ploughed (Sudnik-Wójcikowska & Moysishenko, 2008). Notably in the 1950s and 1960s large areas were ploughed for reasons of the deep fertile soils, mainly chernosems, which are in particular good for crop production and which made Ukraine into the 'grain basket' of Europe.

In Lugansk Oblast very little of the steppe is left, according to last estimates only some 0.43% of the total area (Forosjoek & Aksiom, 2009). In total there are some … considered to be degraded (Figure 6). This estimate is based on up-to-date satellite imagery, however, no field check was done to confirm these data.

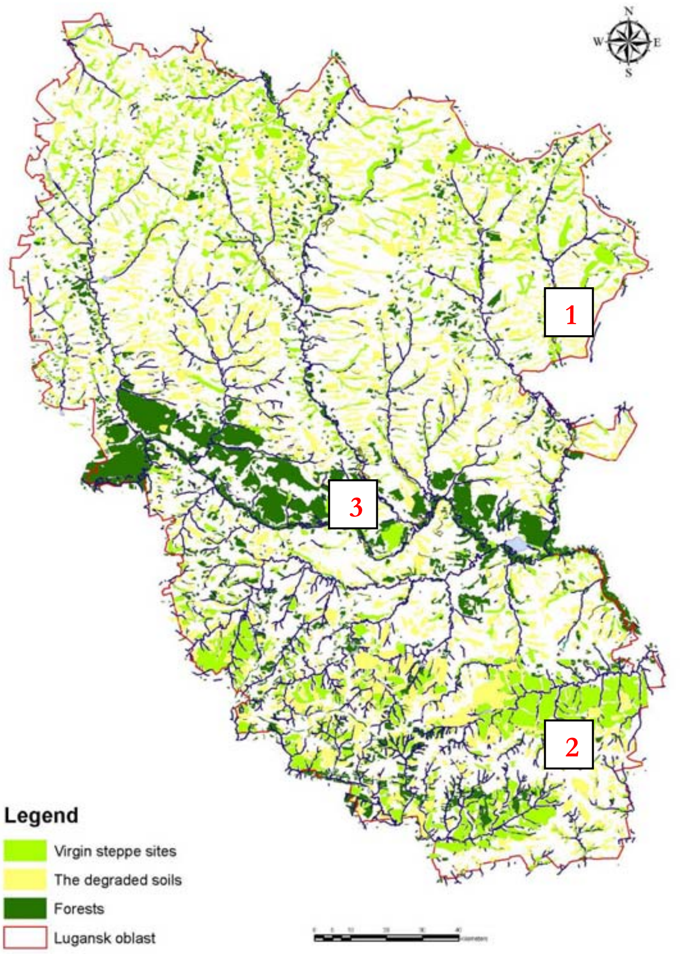


Figure 6: Steppe areas and degraded areas in Lugansk Oblast; Strzelovsky (1), Provalje (2), and Tr'okhizbenka steppe (3); based on satellite imagery and and field investigations (Djos 2009, mapping by A. Axem).

The converted steppe is also prone to degradation: once the protective vegetation is destroyed, gullies develop easily. Through exposure of the soil to high solar radiation the humus decomposes, which results in poor soil structure and increased water erosion. The erosion gullies are known as 'balki'.

Currently, this gives us the opportunity to restore some steppe areas. First of all on the degraded or eroded farm lands that can not maintain their productivity without large external inputs. Second, on those areas where farming is currently not economically viable.

5.2 Main steppe reserves in Lugansk Oblast

Below, some general information about the visited reserves is presented, but available information was distributed in an unbalanced way among the areas. The location of the areas is indicated in Figure 6: Strzelovsky (1), Provalje (2), and Tr'okhizbenka steppe (3). More detailed observations on the vegetation and management is found in Appendix 2.

The **Strzelovsky steppe** (Figure 7) reserve is located in the Central Pontic herb-grass steppe area (M6). Both Strzelovsky and Provalje are characterized by well-developed more than 1 m thick chernozem soils and also chestnut brown soils (humus content 5-7%). Strzelovsky is nearly 650 ha in size. The reserve is at an elevation of some 100-180 m asl. Precipitation is 380-400 mm/yr and January mean temperature is -9 °C. Maximum temperatures can reach +34 °C

From 1805 till 1931 the area was also part of a stud farm until it became a protected area ('zakaznik') and in 1948 declared as a state reserve. This implies that also here in recent history the area was managed by grazing. Important issue is the protection of Steppe marmot (*Marmota bobak*) (Andrienko *et al.* 1999: 74-76, Borovik, 2009).

Figure 7: Strzelovsky steppe reserve (09-04-2009). Left: on the background windbreak of a.o. exotic Fraxinus lanceolata and F. pennsylvanica; part of it survived severe burning by accident. Right: burned bushes of indigenous Caragana frutex, Amygdalus nana and Chamaecytisus ruthenicus (same accident).

The plant species richness is 40-90/100 m^2. Rare plant species are found e.g. *Scrophularia cretacea, Paeonia tenuifolia, Pulsatilla nigricans, Serratula donetzica, Elytriga stipifolia* etc. Many endemic species exist here and ca. 25 species are listed in the Red Data Book of Ukraine (Andrienko *et al.* 1999: 74-76). As a result of expansion in 2004, the reserve includes now pasture areas and abandoned fields (Borovik, 2008a).

Invasive alien forest species form a problem (*Ulmus pumila, Fraxinus lanceolata, F. pennsylvanica, Elaeagnus angustifolia, Acer negundo, Robinia pseudoacacia, Cerasus tomentosa, Prunus divaricata*) (Borovik, 2008b). These species occupy nearly the whole site spectrum in this reserve and accelerate plant community succession. Measures are needed to control these woody species. By declaring the area as a reserve, grazing was forbidden, but mowing is allowed (parts of the area are 'strict reserve', see

Borovik, 2008a). Despite this measure, succession continued and bush encroachment also resulted in the decline of Steppe marmot. Setting back vegetation succession should be profitable for the marmot. If grazing would be allowed as a management tool, the problem of how to get cattle emerges.

The **Provalje steppe** reserve (Figure 8, Figure 9) is located in the transition area of the West and Central Pontic herb-grass steppe (M5) and the Central Pontic herb-grass steppe (M6) (for explanation of the codes see par. 2.2).

The size of the reserve is almost 600 ha and it consists of two nearly equal parts: Kalynivske and Grushevske. The first is situated near the village, the latter is more remote, bordering the Russian Federation. The altitude is 150-230 m asl. Precipitation is rather high (600 mm/yr) and January mean temperature is for steppe conditions is not particularly low (-6 to -8 °C). Minimum and maximum temperatures can reach -30 to -35 and +35 to +40 °C, respectively.

From 1846 till 1945 the area was the property of a stud farm. In 1945 it became a 'kolkhoz' with among others 4,400 cattle and 9,100 sheep. This negatively influenced the steppe area, and in 1975 a reserve was established (Andrienko *et al., 19*99: 80-84). This implies that at least in recent history, the area was managed by grazing, followed by overgrazing, and as a reaction grazing was stopped.

Plant species richness is 40-60/100 m^2. Many *Stipa species* have been recorded (e.g. *S. capillata, S. ucrainica, S. dasyphylla, S. tirsa, S. pulcherrima, S. pennata, S. borysthenica*) and northern steppe species are found such as *Bromopsis riparia, Elytrigia intermedia, Anemone sylvestris, Fragaria viridis, Inula hirta, Trifolium alpestre, T. montanum* and *Myosotis popovii.*

Of the species found here, 25-30 are listed in the Red Data Book of Ukraine: e.g. *Onosma graniticola, Genista tanaitica, Calopha wolgarica*, several *Stipa* species, *Pulsatilla nigricans, Tulipa quercetorum, T. ophiopylla, T. schrenkii* and *Crocus reticulatus* (Andrienko *et al., 19*99: 80-84).

Figure 8: Ruderal habitat (left) and bare soil (right) near Provalje steppe (07-04-2009).

Figure 9: Provalje steppe reserve (07-04-2009). Left: illegal sheep herding in the strict reserve; right: escarpment at the 'rocky steppe'.

Tr'okhizbenka steppe (three-housed steppe, Figure 10) is totally different from the previous reserves. This reserve is situated on terraces of alluvial aeolian sands without any profile or with very little podzol formation. It is located north of the river Severskij Donec (Sivers'kyi Donets) and belongs to Pontic psammophytic herb-grass steppe (M8). The steppe vegetation has an open physiognomy with soil disturbances from military activities (Figure 10) and from bioturbation by mammal fauna and ants.

Tr'okhizbenka steppe area is almost 3 300 ha, situated <100 m above sea level. The area is a former military training area for tanks ('polygon') that is in the process of being legalized as a state nature reserve. There are some small remnants of buildings, soil disturbances (trenches), etc. The area is surrounded by communities that do occasionally use the steppe for grazing and collecting medicinal plants, fruits and mushrooms, but with limited impact. The State Forestry Service destroyed an area that is bordering Tr'okhizbenka steppe by afforestation with *Pinus sylvestris*, which is invading now the designated nature reserve. There are also other invasive tree and shrub species.

Figure 10: Tr'okhizbenka sandy steppe (10-04-2009). Left: soil disturbances (trenches) as a result of former military activities; right: bush encroachment by invading Pinus sylvestris from afforestation by State forestry service outside and by accident inside the area.

5.3 Steppe restoration

In paragraph 2.4 current factors which shape the steppe are described. Grazing can be an important management tool to conserve and restore the steppes and their biodiversity in Ukraine. Different herbivores are used for this purpose, like horses, deer, sheep and cattle. In this section, livestock management and production with cattle and sheep will be investigated.

The current project revealed the very technical and complicated approach in steppe restoration, despite indications that would favor more simple-to-manage ecological approaches. Generally, the agrosteppe approach in Ukraine and Russia is a rather technical and probably sometimes costly agricultural approach, which presumes ploughing and harrowing for clearance of the land. The approach follows largely Dzybov (Euroconsult Mott-MacDonald, 2008).

The internationally accessible literature cited in favor of this approach, is however rather scanty, outdated and not entirely convincing. It seems that limited use has been made of trials for comparison with less invasive approaches. It may, however, work in those situations where land has been tilled for prolonged periods, the soil structure has been altered and the seed bank in the soil may have been destroyed.
In contrast, in an FAO publication which focuses on the Russian situation of steppe restoration, Boonman and Mikhalev (2005) suggest: 'If ploughed land is left undisturbed, it will return naturally to steppe vegetation in six to fifteen years'. The pathway for natural restoration may last ca. 15 yrs, of course depending on the local situation, land use history, frequency, depth of ploughing, the seedbank etc.

1st year annuals;

↓

2nd year biennial and perennial herbs;

↓

3rd year [rhizomatous] *Agropyron racemosum*[3] emerging;

↓

5th-8th year *A. racemosum* over 80% of the herbage
with *Festuca sulcata* (syn. *F. valesiaca*); *F. sulcata* predominant;

↓

9th-15th year (approximately) *Stipa lessingiana* becomes predominant
(return to the initial virgin steppe)."

Pathway for natural restoration of ploughed land (based on: Boonman and Mikhalev 2005)

As said, this gives an optimistic view about the possibilities for steppe restoration. Boonman and Mikhalev (2005) speak about "From fallow to steppe", "Avenues of steppe improvement", "Marginal cropland should return to grass".

From an ecological perspective, it seems in most cases preferable to minimise tillage, so that soil organic matter decomposition will not be stimulated and soil organic matter content will move towards a new equilibrium. This is usually the fastest way to return to a more stable, natural vegetation. Any disturbance will set back the succession, as all ecological handbooks show, which will stimulate development of pioneer species, which are usually ruderal species and forbs. This therefore, favors an approach as propagated by Boonman and Mikhalev (2005).

5.4 Grazing

One of the biggest challenges for preservation of plant diversity is not the restoration of abiotic conditions, but recovery of the processes of seed transport (Ozinga, 2008). There is an overwhelming quantity of ecological literature from other situations and other areas about dispersion of seeds (Van Dorp, 1996, Bonn & Poschlod, 1998, Bouman *et al., 20*00, Steuter, 2005, Ozinga, 2008, Rosas *et al., 20*08, Hovstad *et al., 20*09).

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[3] Syn. *Elymus racemosus*, very rare in Ukraine.

Typical distribution mechanisms for steppe plants are either by wind, endochorous or exochorous dispersal (i.e. through animals, either through their dung, or by seeds sticking to the fur). This has been extensively shown in ecological research. Therefore, extensive grazing should be part of the measures taken to restore degraded steppe.

Livestock grazing is essential in restoration, as has been shown by good results in restoration of abandoned fields into steppe. We observed that steppe species had re-established themselves after land abandonment. The un-resolved question is how these species came here: from small fragments of steppe nearby, dispersion with agricultural equipment, brought by animals, mainly transported by wind?

There is very limited information about steppe restoration in this region, despite some restoration projects that have been in place for almost 30 yrs, and not all (plant) species have returned yet (Borovik, Lugansk Nature Reserves, pers. comm.). By looking at several stages of development of abandoned arable fields, in our opinion, it seems at least possible to make a chronosequence of stages of vegetation succession towards steppe (differences in space as a proxy for differences in time).
In Strzelovsky steppe reserve (Figure 7, Borovik, 2008a, 2008b, 2008c) Borovik demonstrated an old abandoned field (time since abandonment 20 yrs), in those days mixed with sown *Onobrychis* spp., now with dominant *Bromopsis inermis, Poa angustifolia* and *Festuca rupicola*, but steppe species still missing. Therefore, now experiments have been started by seeding the steppe species *Stipa tirsa, Phleum phleoides* and *Koeleria cristata*.

One of the major opportunities for steppe restoration is therefore the establishment of herded grazing with sheep and cattle (Vakarenko & Dubyna, 2006) as a replacement of extinct or decimated natural large herbivores or ungulates such as Przewalski horses (*Equus przewalskii*), Wild asss (*Asinus hemionus*), Roedeer (*Capreolus capreolus*), European bison (*Bison bonasus*), Aurochs (*Bos primigenius*), Saiga antelope (*Saiga tatarica*) or smaller herbivores as Souslick (*Spermophilus* spp)., Steppe lemming (*Lagurus lagurus*) and Steppe marmot (*Marmota bobak*), etc.

Not all of these animals were living on the steppe, but mostly grazing is required to maintain a natural equilibrium.

Most important impact may be that herbivores move between areas: from nature reserve to abandoned fields, and act as vector for seeds, thus strengthen ecological processes in an ecological network (Hillegers, 1993, Burny, 1999, Elbersen *et al., 20*03, Groot Bruinderink *et al., 20*03). Despite the many positive effects of grazing, a major threat is the overgrazing. The big challenge is therefore to balance economical and ecological interest.

Also the trampling and local disturbance due to grazing, as well as re-distribution of nutrients, provides micro-habitats for specific species, both entomofauna and flora. Also here counts that too much trampling, leads to soil compaction, which is disastrous and may result in soil erosion by wind and water (Boonman and Mikhalev, 2005).

Some cases:
Opposite Strzelowsky steppe reserve an abandoned arable field (in former days illegally ploughed; now 7 or 8 yrs abandoned), lying on the northeast bank of river Cherepakha, was visited 9 April and 14 May 2009. This field has a shallow soil on chalk, and was therefore recently brought under cultivation and subsequently abandoned.
Although weeds (*Artemisia absinthium, Carduus acanthoides, Cirsium setosum*) still persist and steppe with Steppe marmot is nearby on the upper part of the slope, some (semi) steppe species were already present in our plot (100 m^2): *Melica transsylvanica, Festuca valesiaca, Salvia aethiopis, Achillea setacea, Artemisia austriaca, Galium humifusum, Linum austriacum, Falcaria vulgaris, Linaria maeotica, Ajuga chia, Alyssum desertorum* and *Erigeron podolicus*. Nearby, *Stipa lessingiana* and *Coronilla varia* were also found. In total more than 40 vascular plant species per 100 m^2 were noticed, more or less the same range in biodiversity as in local steppe vegetation.
These developments show again potentials for spontaneous regeneration into steppe vegetation. Local expert Borovik suggested that for restoration of this abandoned field into steppe, grazing with husbandry would be useful. Also fire as a management tool, just one or two years after abandonment to remove standing dead material of the first pioneer vegetation of arable weeds, could be helpful for restoration.

5.5 Steppe management opportunities

5.5.1 Burning

"Burning is an additional factor, if not a tool, in the management of steppe and semi-desert. Some even believe that the tree-less steppe is the result of burning, rather than climate or soil" (Boonman & Mikhalev, 2005), although this may be overstated.

"Fire has influenced plant communities for millions of years" (Pauly, 2005), and also man has influenced vegetation already thousands of years. There are differences in natural and man made fires, and differences between impact on different species (e.g. *Quercus* vs. *Acer*). Application of fire as nature management tool is very complicated in relation to safety, impact on vegetation and fauna, timing of burning, required experience, etc. Use of fire involves risks as well, water should be present, and very low relative humidity is very dangerous. Pauly (2005) gives a lot of important information about how to handle. Especially springtime should be suitable. "Many ecologists are concerned about the negative impact of fire on insect populations, and recommend leaving half to two-thirds of large remnant prairies unburned each year, so the insects can reinvade the burned proportion". Fire can also control (the invasion) of shrubs and trees (Figure 7).

Serious research is required on the impact of fire as a management tool for restoration of abandoned fields into steppe.

Fire can be an appropriate management tool for restoration just one or two years after abandonment, to remove standing dead material ('starika') of the first pioneer vegetation of arable weeds, as suggested during our mission. Too much dead material prevents establishment of other species.

5.5.2 Bush encroachment

One of the big underestimated threats for the preservation and an obstacle for management and restoration of the Ukrainian steppes is bush encroachment, mostly starting with invasive alien tree and shrub species from windbreaks ('lesopolosy'). We have observed this threat in Strzelowsky steppe reserve (Borovik, 2008b), but also in Provalje steppe reserve and in the Tr'okhizbenka former military area. Not only in the true steppe zones, also in the Desert steppe zone in the south of Ukraine bush encroachment is demonstrated (Sudnik-Wójcikowska *et al., 20*06, 2009a, 2009b, Moysiyenko *et al., 20*09). Windbreaks function also as barriers for tumbleweeds ('perekatipole') and hamper the typical dissemination of these steppe species.
Nature conservation strategies for steppe should focus on combating (invasive) alien wooden species. Planting of these species should be avoided.

Another problem with introduced alien species is that alien *Ulmus pumila* introduced in windbreaks is hybridizing with indigenous U. minor (syn. *U. carpinifolia*). So, indigenous species could also disappear as a result of genetic pollution (Wikipedia). If woody species have to be planted, only indigenous provenance should be used.

5.6 Ecological network development

There are good opportunities for steppe restoration by connecting isolated steppe areas through the the development of an ecological network (in Russia the 'ECONET' approach). This is in line with the national policy (Kostyushin, 2003), but it follows also approaches such as Natura 2000 and PEBLS. The development of ecological networks is of particular importance in such fragmented situations as we encounter in Lugansk Oblast, corridors are essential for migration of flora and fauna, and re-population of species that may have disappeared (Sluis *et al*., 2004, Bouwma *et al*., 2002). An ecological network with core areas, connected by corridors, will facilitate the necessary exchange processes and spread of species, and faster recovery of steppe. There are good examples and good approaches which can be used under the local conditions in the Ukraine.
A start has been made with the identification of transboundary corridors with Rostov Oblast (Van der Sluis, in prep.). In the long term this may even facilitate the return of large herbivores and other large mammals from larger extensive steppe areas in east, such as Kalmykkia.

5.7 Climate change

An assessment of the impact of climate change was not part of this study. There are indications that climate change has an impact on steppe, in particular the establishment of (often exotic) tree species. It is important to look beyond anecdotic information and to pay more attention to the phenomenon of climate change in relation to steppe conservation. Monitoring is essential to keep track of such environmental changes. Ecological networks (ECONET) are very important to counteract the impact of vegetation changes and allow for migration of species (Bouwma *et al.*, 2002, Van der Sluis *et al.*, 2004. This is a strategy to decrease the vulnerability of the ecosystem (Geertsema et. al, 2009.)

6 Conclusions and recommendations

6.1 Introduction

The basic conditions for farming exist in Lugansk Oblast but further productive development requires new impulses and innovative approaches. Steppe can be used for profitable livestock production when it is integrated in a system of a farm with arable land, situated close to steppes and within a good infrastructure of regional agricultural production. This is shown in the SWOT analysis below (par. 6.2).

Several stud farms were visited which were not privatized till now. This gave some reminiscences of a system where mixed-farming with crop and livestock was community- and family-based (Boonman & Mikhalev, 2005). Provalje and Strzelovsky steppe reserves were in the 19th century part of such a system. In spite of the cultural heritage, we see less or no future for horses because of the absence of practical value, in contrast to cattle and sheep.

These data and calculations are partly based on assumptions from the Dutch feed evaluation system and from general data on forages in East Europe. From Ukraine, only the analyses of a few grass samples have been used. More local data and knowledge from Ukraine should be collected: nutritional and production values of feed/forage crops, different agricultural systems, climate data and economic data. Also data from different grass and animal species should be compared. The nutritional value of other feed from crop residues should be analyzed to formulate good diets for the animals.

6.2 SWOT analyse

A SWOT analysis was performed on the strengths and weaknesses of the agricultural sector in this part of the Ukraine. Despite all hardships encountered, there are also considerable strengths of the sector, that could bring the sector back in the frontline of the Ukrainian economy.

STRENGTHS

- Low costs for land rent
- Low labour costs
- Very good, productive soils
- Presence of high-value nature
- Unique position of steppe in Europe
- Existing agrarian knowledge system
- Good financial support program

WEAKNESSES

- Lack of entrepreneurship
- Access to capital (bank loans)
- Marketing opportunities perishable products
- Market imperfections (milk and meat)
- Weak position Zapovidnyk among stakeholders
- Distance to markets
- Climate – water availability in summer
- Endemic diseases
- No tradition of crop insurance

OPPORTUNITIES

- Basis for infrastructure exists
- Opportunities for Green tourism
- Cultural identity Steppe
- Possible combination animal husbandry with steppe
- Increased production steppe grasslands
- Access to West and East European markets
- Diversification
- Sheep farming on steppe
- Demand for agro-products: milk, beef, honey
- Development Econet

THREATS

- Migration and social changes (youth)
- Volatility of world markets
- Political instability
- Anticipated climate change & impact on steppe

More research is necessary and existing information should be made accessible for a better prediction of the value of steppe grass in a livestock production system on a farm or in a specific region. There is a long tradition of research, some information will be available only in Russian literature and was not available in this project. For well-founded conclusions, more data and local knowledge from different seasons should be collected on:

- nutritional and production values of feed/forage crops
- climate
- socio-economic conditions
- food quality and safety
- rights to use the steppes.

Furthermore, additional research is required:

- more laboratory analyses of grass samples and different grass species
- comparison of different agricultural systems: from households with 2 or 3 heads of cattle up to farms with 1000 head of cattle (i.e. different animal diets, feeding systems and animal breeds)

- stocking rates on steppes during the year and in combination with supplemental nutrition (concentrates) for cattle and/or sheep.

Steppes provide enough nutritive value for grazing ewes and older lambs (although in a dry autumn, the intake of energy can be too low for the older lambs). These animals don't need supplements and can graze on steppes far away from the farm. Younger lambs should be fed supplemental concentrates.

In spring, growing beef cattle can be grazed on steppe grass without supplements. Dairy cattle need supplementary feeding with concentrates.
Most farms can produce concentrates because of the availability of appreciable areas of arable land. Another advantage is that the basic infrastructure of livestock production is still available in the Ukraine, like summer camps on the steppes.

Dairy cows should be grazed near the farm or in summer camps, because the milking process requires supplemental feeding. Other animals can graze further away, depending on the quantities of concentrates that should be transported. Experiences with summer camps and outdoor milking (mobile apparatus) exist in Lugansk Oblast.

There is limited information about the 'seed bank' and 'seed deposition'. It is recommended to conduct more local research on this topic.

Currently, virgin steppe areas are still ploughed in Ukraine for establishment of very marginal artificial woodland (plantations of Pinus sylvestris) as a compensatory measure for losses elsewhere (Fig. 15). This practice is disastrous for the preservation of the natural and cultural heritage of Ukraine. Better practice would be the use for this purpose of abandoned fields (former agricultural land) with poor perspectives for steppe regeneration.

Grazing is one of the best management methods for farms, provided that appropriate grazing levels are used. "As for grass resources, natural grasslands may seen insignificant in their outward appearance and even less so in their response to improved husbandry. In spring their start is slow and growth ceases earlier in autumn, compared with elite sown grasses. However with the same amount of intelligent care, primary (natural or virgin) grassland often needs no replacement at all by sown pasture grasses, let alone by legumes."
(http://www.fao.org/docrep/008/y8344e/y8344e0h.htm accessed 25 Nov 2009)

6.3 Farm production models

Based on field observations demonstration projects can be developed on farms. Farmers can learn from each other using these cases. The project team has visited the following sites in April 2009. These cases are interesting as pilots to find answers on a lot of questions from the discussion.

We suggested as a favorable model a combination of (remnants of) virgin steppe and/or abandoned fields to be brought into steppe, a 'buffer zone' with cereals and leguminous species and agricultural land: for grazing, hay making and producing concentrates.

6.3.1 Case 1: Provalja Steppe Zapovidnyk

Provalja steppe zapovidnyk is a nature reserve located in the south of Lugansk Oblast (see 5.2). Some existing large farm is grazing next to the protected area, which activities could well be combined with the conservation of the area:

- Existing farm:
  - Cropland and 'farm steppes'
  - 400 dairy cows (2800 kg milk / year, life of 8 to 9 year, Red Steppe breed, 450 kg LW, 1 calf/year
- Summer (May till November) using summer camp (milking): grazing steppes and feeding maize silage + concentrates at camp
- Winter (shed): maize silage + concentrates (home-grown)
- Calves (shed): 2.5 years of growth required for beef (feeding straw and hay from own land); some calves are kept for replacements
- Farm steppes are too intensively grazed: prevention of overgrazing is possible provided that:
  - Also steppes of Zapovidnyk and buffer zones are utilised
  - Dairy cows are kept close to farm or summer camps
  - Sheep and beef cattle graze further away

6.3.2 Case 2: Harmasowska Farm, Bilowodsk

The team visited a farm at Harmashovka, in the North of Lugansk Oblast. The farm has cropland, steppes and 300 ewes. The farmer had plans to expand towards 1000 beef cattle and 3000 sheep.

We saw interesting possibilities in agricultural management, integrating economic and ecological goals. A model was proposed comprising a combination of remnants of virgin steppe, 'buffer zone' and agricultural land: for grazing, hay making and producing concentrates.

In the buffer zone there is possibility for production of cereals in combination with Leguminosae (Fabaceae): sainfoin (*Onobrychis spp.*) or lucerne (*Medicago sativa ssp. sativa*) to make hay and silage. There we noticed not only ruderalia as *Capsella bursa-pastoris, Thlaspi perfoliatum* and *Artemisia absinthium*, but also (semi) steppe species: e.g. *Alyssum desertorum, Ajuga chia, Festuca rupicola* and *Viola ambigua*, again demonstrating potentials for restoration of steppe, as well as for agricultural activities together with biodiversity qualities.

The agricultural land is used for producing concentrates (barley, maize). Based on this, we had the following recommendations:

- Start with 100 cows (if credit can be secured)
  - Female calves retained for herd expansion
  - Male calves retained for beef production (in 1 year 350 kg of growth)
- May till November: production based on steppes + concentrates (home-grown)
  - Farm steppes (between crop land), using summer camps: cows with calves
  - Steppes further away: sheep + older beef cattle
  - Advice: include dairy cows, because of existing summer camps + experience with milking in summer camps.
- Sheep: 300 ewes (2 lambs/ ewe; breed: Romanov en Askania)

6.3.3 Case 3: Strzelowsky Steppe Zapovidnyk

The third case was the Strzelowsky Zapovidnyk (nature reserve), where steppe management requires grazers. The reserve is located in the north of Lugansk Oblast. Nearby the reserve is a fairly new, well-managed dairy farm since two years: 'Dagestan' (named after the origin of the owner, from Dagestan). The farmer has currently 200 dairy cows, some cropland and farm steppe. In addition the farmer fattening of young cattle

  - Summer:
    - Dairy cows are grazing close to the farm (milking on-farm)
    - Young cattle: held at the farm
    - Feed: grass, hay/straw, concentrates (home-grown?)
- We recommend for this farm:Summer camp(s) for cattle from 'Dagestan' farm on Zapovidnyk

6.4 Recommendations

Restore and expand steppe

As was shown in the cases above, steppe can provide important habitat for livestock grazing and is often available at low costs. Steppe produces good quality stock feed at low costs – if supplementary feeding is provided for the necessary micro-elements and nutrients.

Steppe is the identity of the area, and is engrained in the local history, which is closely related to the Cossacks as well as the horse-breeding in the region. Promoting this cultural aspect will enhance local and national tourism, as well as regional development.

Development of an Ecological network

To utilize the opportunities of restored steppe ecosystems, the Oblast should aim for the development of an ecological network (ECONET). There are good opportunities to connect fragmented patches of virgin steppe, small remnants of steppe vegetation. These patches of steppe are mostly found in dry river beds ('balkas') and river

valleys, and can connect to the larger, protected steppe reserves. Once connected this will result in an larger effective steppe area.
The ECONET will connect to the larger national and international ECONET and result in a more stable ecosystem in the light of climate change.

ECONET for rural development
There are good opportunities for steppe restoration by connecting isolated steppe areas through the ECONET approach, in line with the national policy in the Ukraine. The development of ecological networks is of particular importance in such fragmented situations as in Lugansk Oblast. Here corridors are essential for migration of flora and fauna, and re-population of species that may have disappeared. An ecological network with core areas, connected by corridors, will facilitate the necessary exchange processes and spread of species, and faster recovery of steppe.
The development of the ECONET also can form an innovative start for rural development (Bolck *et al.*, 2005). Measures are urgently required to maintain productivity, and to develop new approaches for the rural economy, a new 'engine' for development which will support the population in rural areas.

Grazing management
The use of grazing herbivores on the steppes will be stimulated, when they also can be kept for socio-economic reasons as tourism or livestock production. On a small scale, horses could still have a function in an ecotourism concept (Kusters, 2008).
Grazing is essential for maintenance of steppe, and it should therefore be encouraged by nature conservation as well.

Protection of cultural heritage
Special attention is needed for steppes as cultural heritage. Important archeological sites are present in steppe. Especially grave mounds ('kurgany') that were usually not ploughed. Many of these sites are not properly protected, not marked out in the field, and they are destroyed by people collecting soil or building materials as was also shown during a field trip in October 2009. These sites with preserved steppe vegetation, serve as nuclei from which steppe species can disseminate into abandoned fields.

Steppe extension
Extension of the area of steppe reserves has priority above the improvement of the quality of actual steppes. Now there is momentum for extension of steppe, due to the agricultural and economical crises. Improvement of habitat quality will take time; but under proper nature management time will be on the side of conservation, in 15 years already good steppe territory can develop.

Position of conservation authorities and NGOs
For enlargement of reserves or improvement of landscape connectivity, parcels of land have to be acquired. We conclude that the position of those organizations for their activities has to be strengthened. At several occasions our attention was drawn to the impossibility for nature reserve organizations or NGOs to buy land, to pay for

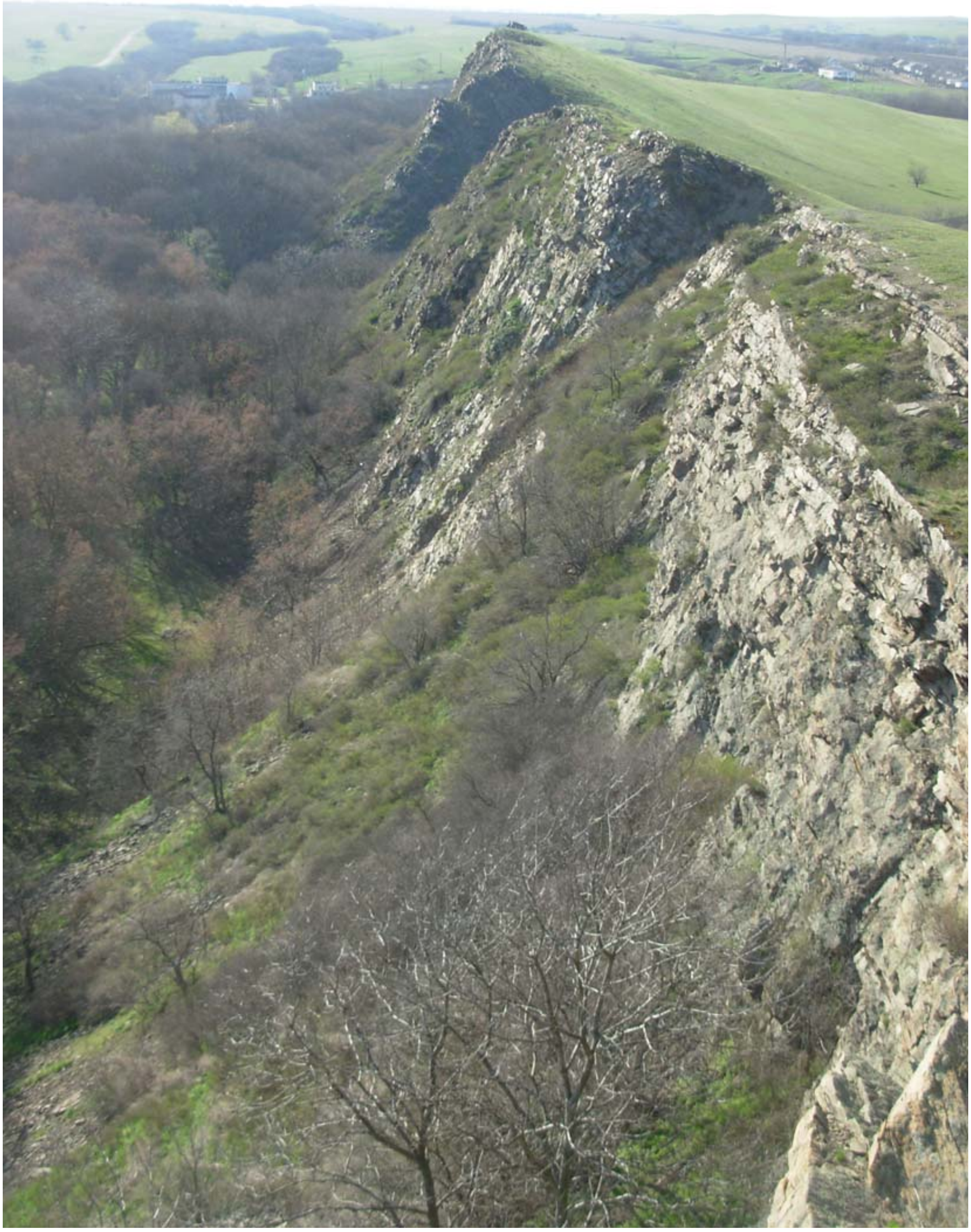
renting land, or at least meeting big difficulties for such actions. Ownership of abandoned areas is also not always clear, and difficult and expensive to establish.
Nature reserves have limited possibilities to get income from their own 'polygons' for subsequent spending on management. The reserves are depending on the national state budget, and financing by the local government is not allowed. There is hardly money for measures for nature management, e.g. for hay, and if there is hay to sell no one would buy it.

6.5 Capacity building

After meeting local researchers and managers of different disciplines several possibilities for training and empowerment of people and organisations. Training needs of e.g. Mmes. Borovik, Sova, Vakarenka, Demina etc. could be inventoried.
At first training in foreign languages (e.g. English) would be very helpful for easier orientation on international (West European, American) scientific literature as well as on (restoration) ecology, biological conservation, soil science, landscape ecology (MacArthur & Wilson) etc., and for contacting foreign colleagues. With this, our colleagues in Ukraine would be in an unique position to bridge the gap between West en East. Publishing in international journals could be supported. Perhaps there are possibilities for a sabbatical, training, PhDs, fellowships, grants, etc. on Wageningen UR, e.g. at the Environmental Sciences Group (Prof. Frank Berendse), Plant Research International (Prof. Herman van Keulen), Animal Sciences Group, etc.
Empowerment of the position of the nature reserves ('zapovidnyki') is needed in the field of extension of reserves, grazing and burning as tools for management, etc.
Also more extensive cooperation could be developed between different ecologists within Ukraine, and between experts from Poland, Moldova, Ukraine, Russian Federation, etc.

Scientific research, including practical studies, has to be done in the field of restoration ecology on seed bank, dispersion, odd fields (abandoned arable fields), grazing systems (wild herbivores, husbandry), invading alien woody species, management (grazing, mowing, burning), possible impact of climate change, etc. A monitoring program with permanent plots (iron markers in view of burns), in combination with exclosures is extremely necessary.

In general, it would be useful to examine already the laws and regulations of EU on nature, environment, private participation and NGOs in the field of nature and environment.



Rocky steppe

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Wild tulip

Appendix 1 Fact-finding mission and fieldwork Lugansk

6 April was an introduction. A lot of information given by Markov and some local experts (e.g. Lugansk National Agrarian University: Mr. Goebarev; agrarian entrepreneurs: Mr. Kornienko and Mr. Surnachov). The Lugansk Institute of Agricultural Production (Academy of Agrarian Science) in Memallusm (north of Lugansk) was visited for information on possibilities for analysing grass samples.

7 April a field visit was made to Provalje (Provalski/Proval's'kyi) steppe reserve ('zapovidnyk'), ca. 75 km southeast of Lugansk, near Sverdlovs'k, at the border of the Russian Federation. A local farm was visited. From this moment, the expert team was accompanied by the excellent local botanical researcher Mrs. L.P. Borovik of Lugansk Nature Reserves. In each reserve visited, local wardens were assisting in the field.

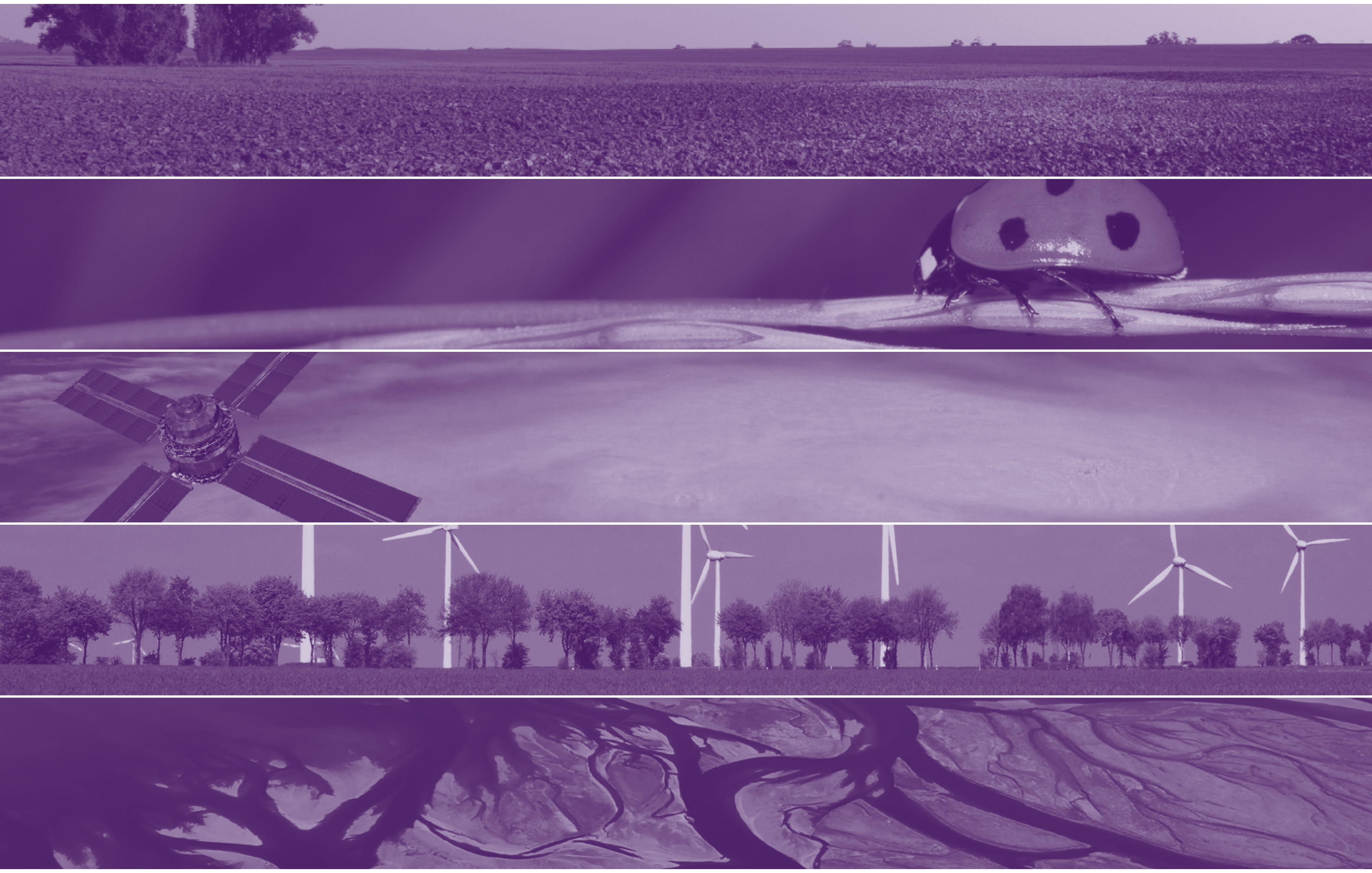
8 April a travel was made to Belovodsk (Bilovods'k), ca. 100 km northeast from Lugansk. This was starting point also the next day for meetings with agricultural companies (Mr. Vasilyevich at Harmashovka, 'model farmer', with cattle and sheep; the Rayon Administration of Belovodsk, and a meeting with several local experts on horse farms (Novolimarevka & Novoderkoel).

9 April Strzelovsky (Striltsivski/Strilets'kyi) steppe reserve, ca. 45 km northeast of Belovodsk, also at the western border of Russia was visited. 'Dagestan farm' near Strzelovsky steppe reserve.

10 April an intensive discussion was held at Stanychno-Luhans'ke (north of Lugansk) with Mrs. Sova, director of Lugansk Nature Reserves. Subsequently, the team visited together with colleagues of the nature reserves Tr'okhizbenka (Trechizbenka) steppe, a former military training area ca. 50 km northwest of Lugansk.

From the 11th-15th of May 2009 Lugansk oblast was visited again which was logistically facilitated also by Mr. Markov. Slim was now accompanied by Prof. dr. B. Sudnik-Wójcikowska PLN (University of Warsaw, Department of Plant Ecology and Environmental Conservation), Dr. I.I. Moysiyenko UA (O.V. Fomin Botanical Garden of National Taras Schevchenko University of Kyiv & Kherson State University, Department of Botany) and Dr. L.P. Vakarenko UA (M.G. Kholodny Institute of Botany, NAS of Ukraine, Kyiv).

Fieldwork was done by the members of this expedition by repeated visits to Tr'okhizbenka steppe area (12 May), to Provalje steppe reserve (13 May), and to Strzelovsky steppe reserve (14 May). In Strzelovsky, the team was again led by Mrs. L.P. Borovik.



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