GUIDELINES ON FURTHER PROJECT DEVELOPMENT

WP 3 Studies and training

Activity 3.3 Guidelines for further project development

GECO2 – Green Economy and CO2

Safety and resilience | SO 2.1

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Introduction

GECO2 (Green Economy and CO_2) is an Italy-Croatia Interreg project aiming at setup and experimentation of voluntary carbon markets in the agricultural sector. This document is an important preliminary step on building the experimental part of the GECO2 project.

These Guidelines for further project development represent the basis on which the operational tools (protocols) of the pilot phase will be designed.

On the basis of the studies carried out on WP 3.1 and of the technical seminar results carried out by all the project partners within WP 3.2, a multilingual document in the form of technical guidelines was produced in order to give shared and reliable procedures to pilot project implementation.

This document was developed with the participation of all project partners and with the contribution and validation of the GECO2 project Scientific Committee.

As an introduction a series of existing significant initiatives, methods and protocols in use in farms in the project regions have been presented in order to give a picture of the project scenario.

The content of the document is shared into five sections.

The first section collects indications concerning the realization of a cultivation protocol with reference to risk reduction for soil in agriculture, adaptation and mitigation, agricultural practices. In particular: use of organic and innovative fertilizers (e.g. biochar) development of integrated systems; optimum management of pruning and mulching; management of agricultural wastes; practices of insertion of hedges and wooded bands for the containment of soil erosion effects, pollution; side effects increasing biodiversity and systemic ecosystem services (landscape, hydrological cycle, erosion effects, recharge of bogs, etc.).

The second section of the guidelines has been focused on defining the criteria for calculating, evaluating, implementing and validating CO2e absorption/emission actions

The third is dedicated to the market rules: carbon credits generation/transaction, suggested principles and procedures for a fair development of a carbon market.

A further section is devoted to the preparation of a legal contract model defining farmers and buyer's commitment and benefits.

The last section gathers indications on how to design and set up an integrated geo-linked database system, able to collect data regarding farmers and firms participating in the project and to manage in a transparent and integrated way the credits register.

State-of-the-art

In this section, existing initiatives, methods and protocols in use in farms in the project regions are listed and explained.

Sustainable agriculture is a type of agriculture that focuses on producing long-term crops and livestock while having minimal effects on the environment. This type of agriculture tries to find a good balance between the need for food production and the preservation of the ecological system within the environment. In addition to producing food, there are several overall goals associated with sustainable agriculture, including conserving water, reducing the use of fertilizers and pesticides, and promoting biodiversity in crops grown and the ecosystem. Sustainable agriculture also focuses on maintaining economic stability of farms and helping farmers improve their techniques and quality of life.

Existing initiatives

The **common agricultural policy** (CAP) offers a number of instruments to find adequate answers to the challenges of climate change, including a more sustainable EU agriculture. In the following, these instruments are described.

- **Agri-environmental Payments: [….] they can also support measures for organic agriculture Organic Agriculture**, according to IFOAM, "is a production system that sustains the health of soils, ecosystems, and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects"https://www.ifoam.bio/why-organic/organic-landmarks/definition-organic". Under the EU legislation the total area under organic farming in the EU continues to increase, and in 2018 covered 13.4 million hectares of agricultural land. Organic area made up 7.5 % of total EU agricultural land in 2018.

Integrated agriculture or Integrated Production, according to IOBC is a concept of sustainable agriculture based on agroecology and a system approach that aims at contributing to sustainable, resilient, profitable and robust farming systems. **IPM (Integrated Pest Management)** is the part of IP focusing on pests, pathogens and weeds.

Greening actions: the actual CAP framework includes the so-called greening measures (EU regulation 1307/2013, EU delegated regulation 639/2014, EU implementing regulation 641/2014). Under this scheme farmers receive the greening payment if they comply with three mandatory practices that benefit the environment (soil and biodiversity in particular). The three actions farmers have to put in place are: crop diversification; maintaining permanent grassland; dedicate 5% of arable land to areas beneficial for biodiversity: Ecological Focus Areas (EFA), for example trees, hedges or land left fallow that improves biodiversity and habitats. . EU countries have to allocate 30% of their income support to "greening".

Climate-smart agriculture (CSA) is an approach, a system, promoted by FAO that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate. CSA aims to tackle three main objectives: sustainably increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions, where possible. (see Climate-Smart Agriculture Case Studies 2018. Successful approaches from different regions. Rome. 44 pp. http://www.fao.org/3/CA2386EN/ca2386en.pdf)

The **4 per 1000 initiative**, defined during COP 21 in Paris aims at increasing the organic matter content of soils, with a special focus on agricultural land, in order to contribute to food security, adaptation to climate change, and mitigation of climate change (http://4p1000.org).

Existing methods and technical regulations

In order to develop the cultivation protocols and to select the farms that will participate in the project it is important to define existing effective methods in conservation or increase farm organic matter. Listed below are agronomic methods, techniques and protocols in use, which bring important results in preservation of the quantity of organic matter in the soil or in stock creation (in soil or vegetation).

Conservation agriculture: is a farming system that can prevent losses of arable land while regenerating degraded lands. It promotes maintenance of a permanent soil cover, minimum soil disturbance, and diversification of plant species. It enhances biodiversity and natural biological processes above and below the ground surface, which contribute to increased water and nutrient use efficiency and to improved and sustained crop production .

Farm ecotones as plant/soil carbon stock Ecotones with trees and shrubs (hedges and rows, small woodlands and meadows) areas provide a multitude of ecosystem services and sequester carbon in both above- and below-ground biomass.

Existing methods to reduce soil loss

Annual soil loss figures for perennial pastures and agricultural systems range from 0.5 to 5 t/ha/yr., depending on slope, soil type, vegetative cover and rainfall.

Keyline design is a landscaping technique of maximizing the beneficial use of the water resources of a tract of land. The "Keyline" denominates a specific topographic feature related to the natural flow of water on the tract. Keyline design is a system of principles and techniques of developing rural and urban landscapes to reduce rainfall soil erosion: splash erosion, sheet erosion, rill erosion, and gully erosion. Key line design is used in organic and regenerative agriculture and in permaculture.

Soil and Water Bioengineeringpursues technological, ecological, economic as well as design goals and seeks to achieve these primarily by making use of living materials, i.e. seeds, plants, part of plants and plant communities, and employing them in near–natural constructions while exploiting the manifold abilities inherent in plants. Its application is based on use of living plant materials to provide some engineering function in all fields of soil and hydraulic engineering, especially for slope and embankment stabilization and erosion control.

Existing certifications and labeling

There are many initiatives worldwide for the certifications of agricultural practices ranging from public to private ones:

Good agricultural practice (**GAP**) is a certification system for agriculture, specifying procedures (and attendant documentation) that must be implemented to create food for consumers or further processing that is safe and wholesome, using sustainable methods.
Organic standards cover all crops and almost all livestock. Standards for fish farming, bee-keeping and harvesting of wild products are increasingly being developed by the various standard-setting bodies. Organic standards for plant production typically include: criteria for conversion periods; seeds and propagation material; maintenance of soil fertility through the use and recycling of organic materials; and pest, disease and weed control. The use of synthetic fertilizers and pesticides and of genetically engineered organisms is prohibited. There are also criteria for the admission and use of organic fertilizers and natural pesticides. In 2007, the Council

of the European Union approved Council Regulation 834/2007 setting out the principles, aims and overarching rules of organic production and defining how organic products should be labeled. This Regulation, still in force, is complemented by several Commission implementing acts on the production, distribution and marketing of organic goods.
All these legislative acts are the legal basis that govern whether goods can be marketed as organic within the EU, including those that have been imported from non-EU countries. The regulations also define how and when the EU organic logo can be used. There are additional specific regulations governing aquaculture and wine production.

GLOBALGAP The GLOBALG.A.P. Certificate, also known as the Integrated Farm Assurance Standard (IFA), covers Good Agricultural Practices for agriculture, aquaculture, livestock and horticulture production. It also covers additional aspects of the food production and supply chain such as Chain of Custody and Compound Feed Manufacturing.

The IFA standard was revised through an extensive stakeholder involvement and consultation process and V5 was published in July 2015 with a one year conversion period. This means that the V5 became obligatory in 2016. EUREPGAP was a private certification system driven by 22 large-scale retail chains in Europe that form the core members of the Euro-Retailer Produce Association (EUREP). The EUREP Good Agricultural Practices (EurepGap) scheme brings those 22 retailers together with large-scale fresh produce suppliers and producers. Furthermore, there are associate members from the input and service side of agriculture (mainly suppliers of agrochemicals, certification bodies and consultancy firms). The associate members may participate in meetings, but they are not part of the EurepGap decision-making process.

Environmental labels

For what that concerns environmental labels, with the increasing consumer awareness about the ecological impact of the goods and services they buy, environmental labeling has emerged as a key tool for making sustainable purchasing decisions. The commercial benefits of environmental labeling for both buyers and suppliers has given rise to a multitude of environmental claims, labeling schemes and initiatives, each offering different measures and benchmarks. The ISO range of standards for environmental labels and claims give us a picture of the reglementary scenario where the project inserts. In the Annex B you can find more detailed indications about these labels.

A. Guidelines for a cultivation protocol

In this section guidelines of cultivation protocols earmarked to the increase of organic soil substance with reference to the main agricultural sectors (including herbaceous crops, pastures vineyards, olive groves and orchards.) valuable for the project are described.

In the first part of the protocol, farmer's characteristics and selection of the sectors/areas in the partner regions, where it will be developed in the pilot phase, will be justified and established.

The main criteria for selecting sectors can be summarized as follows:

- economic relevance and territorial coverage;
- sector's propensity to innovation and environmental protection practices;
- use of cultivation protocols in line with GECO2 objectives;
- in-built characteristics of the sector in terms of CO2e absorption capacity and presumption of positive emission/sequestration balances of Co2;
- general consistency of the selected territories in the partners regions, considering Bioclimatic characteristics.
- taking into account objectives and limits of the project, farmers' selection will give priority to those farms already in possession of data on organic coal in soil and of measures of organic substances in soil.

General objective and principles

The objective of these sustainable agriculture guidelines is to be used as a reference cultivation protocol devoted to improve the management of land traditionally cultivated in a sustainable manner, and to increase soil capacity to sink carbon, and bring benefits to the environment.

In order to achieve the above mentioned objectives, the project partners should harmonize and coordinate their efforts for promoting integrated land resources, enhancing integration of environmental concerns into agricultural practices while improving quality of life, strengthening local economies and communities, and conservation of natural values and cultural heritage.

The protocol therefore, will include the following proposed actions:

a) Developing, amending and implementing site specific strategies at farm level characterized by an integrative and inclusive approach, in order to increase soil organic carbon, and plant carbon stock, considering the specific environmental conditions;

b) Promoting the sustainable and/or extensive agriculture environmental practices, land resource management practices and organic production to protect biological and traditional cultural landscape diversity, natural and semi-natural habitats including grasslands and woodlands;

c) Promoting the compost production and use in the local rural system;

d) Promoting the conservation and sustainable use of genetic resources for food and agriculture, local breeds of domestic animals, cultivated plant varieties and crop wild relatives;

e) Promote association of local agricultural producers of the same production area;

f) Taking into consideration existing local varieties as well as participations in programmes/projects concerning agro-biodiversity;

g) Promoting organic production, local farmer markets, artisan food producers, community supported agriculture and other forms of small-scale sustainable food production in the framework of proximity and sustainability.

h) Farmers participation into advanced training on rural environmental matters and practices;

i) Integration with existing regional agricultural and rural development programmes focused on environmental protection and CO2e emission reduction;

l) Evaluate existing innovations practices in rural carbon capture, waste, and energy management, smart energy and waste free solutions and systems.

The following principles will be the key elements for the definition of the cultivation operating protocols that will be proposed to farms in the pilot experimental phase of the project. According to the protocol, farm selection will consider already existing agricultural practices to regenerate soil organic matter.

General issues and operational indications on soil organic carbon regeneration and conservation

According to Rattan Lal, the world's cultivated soils have lost between 50 and 70 percent of their original carbon stock, much of which has oxidized upon exposure to air to become CO_2. Increasing the organic matter content of agricultural soils, contributes to food security, and is a key practice to adaptation and mitigation of climate changes. Organic matter determines the physical, chemical, and biological properties of soil and is considered one of the main indicators of its quality: Soil Organic Matter (SOM) contributes to productivity and soil fertility; it increases soil water retention and reduces erosion problems (i.e. adapt to a changing climate with less frequent and regular precipitation and more extreme rainfall); and the regeneration of soil carbon stocks mitigates the Anthropic global greenhouse gas (GHG) flux.

In this frame it is important to point out the difference between **carbon fluxes** into the plants and soil (**carbon sequestration**) and **carbon stocks** in the soil (**carbon storage**). Carbon sequestration is a net removal of CO2e from the atmosphere and can be quantified for a given duration.

According to Olson et al. (2014), **soil carbon sequestration** is "the process of transferring CO2 from the atmosphere into the soil of a land unit, through plants, plant residues and other organic solids which are stored or retained in the unit as part of the soil organic matter (humus). Retention time of sequestered carbon in the soil (terrestrial pool) can range from short-term (not immediately released back to atmosphere) to long-term (millennia) storage"; and according to Bastin et al., (2019), **plants carbon sequestration** "is the reforestation with long-lived trees (>100 years)", with the global potential of 1.2 trillion trees would offset some 10 years of CO2 emissions and sequester 205 billion tons of carbon.

According to Chenu et al. (2019), **soil carbon storage** is "the increase in SOC stocks over time in the soils of a given land unit, not necessarily associated with a net removal of CO2 from the atmosphere. For example, adding the available manure resources on a given agricultural field rather than spreading it homogeneously over the landscape may locally increase SOC stocks (where manure has been added), but not increase the associated CO2 removal from the atmosphere at the landscape scale. While storing organic carbon for long times is preferable in terms of GHG mitigation, labile fractions of SOC (e.g. with residence times of months to years) are essential in terms of soil fertility (their mineralization provides nutrients to plants), of soil physical condition (aggregate stability largely depends on labile C), and of soil biodiversity (labile organic matter being the trophic resource of organisms)."

In managed ecosystems, such as cropland and pastures, both the rate of carbon input as well as the rate of soil C loss via decomposition are impacted by the soil and crop management practices applied. In general, soil carbon stocks which removes CO2 from the atmosphere can be strengthened by:

a. increasing the soil/plants systems of carbon sequestration,
b. enhancing soil carbon storage promoting the constancy of carbon compounds production, such as humic substances, and bio-stimulating systems (such as the Mycorrhizal Fungi Associations and glomalin)
c. maintain soil carbon storage, through rate of carbon loss reduction (by tilling practices, weathering erosion and biogeochemical decomposition), which reduces emissions to the atmosphere that would otherwise occur.

Practices to increase soil C stocks include well-known, proven methods and techniques, or "best management practices" (BMP) or "Regenerative Agricultural Practices" for increasing soil carbon. Regenerative agricultural practices can turn back the carbon in soil, reducing atmospheric CO2 while also boosting soil productivity and increasing resilience to floods and drought. Such agronomic methods include conservation tillage, cover crops and carbon regeneration practices.

The following management practices, increasing carbon inputs and/or reducing carbon losses, can be a reference for GECO2 project development:

a. Grow perennial pasture integrated with arboriculture

A period under perennial, grass-dominant pasture is an effective way of increasing organic matter in soils. Short-lived annual grasses are a source of dead roots; perennial grasses are a source of leaf matter. Even short periods (1–2 years) under pasture can improve soil structure, even though the actual increase in organic matter may be small. Conversion of marginal land to permanent grassland has gained interest because of the large potential in improving soil quality while reducing GHG emissions from marginal land. The average combined net GHG emission reduction when converting from cultivated land to permanent grassland was estimated to be approximately 2.55 Mg CO2e ha^{-1} $year^{-1}$. This potential is expected to decline with permanency of the cover. Permanent cover is related to high C sequestration coefficient and the sequestration potential is estimated to be from 0.7 to 0.9 t CO2 ha^{-1} $year^{-1}$ for 20 years.

b. Implement rotations in annual weed crops

Crop rotation scheme based on Mediterranean annual crops is the main scheme intended as complication of the agroecosystems, helps the maintenance of the level of SOM. A rotation scheme is compulsory in organic agriculture farms, because it allows greater carbon sequestration; the intensification of the cropping system is one of the strategies used to mitigate climate change. In Mediterranean countries, rotations may include: Fabaceae or Leguminosae such as field peas (*Pisum sativum*), dry beans (*Phaseolus vulgaris*), soybeans (*Glycine max*), faba beans (*Vicia faba* or *Faba vulgaris*), lentils (*Lens culinaris Medik*.); forages such as clover (*Trifolium* spp.), alfalfa (*Medicago sativa*), sweet clover (*Melilotus officinalis*), meadow bromegrass (*Bromus riparius* Rehm.), timothy (*Phleum pratense*) and orchard grass (*Dactylis glomerata*); and cover crops such as, berseem clover (*Trifolium alexandrinum*), hairy vetch (*Vicia villosa*), winter wheat (*Triticum aestivum*), red clover (*Trifolium pratense*), annual alfalfa, Italian ryegrass (*Lolium multiflorum*) and sweet clover (*Melilotus officinalis*).

c. Creation of Ecological Focus Areas

EFAs are an important tool for habitat maintenance. Many valuable habitats and the biodiversity they encourage rely on farming systems. However, the efforts to safeguard this biodiversity are not recognized by markets and therefore not reflected in the price's farmers receive for their produce. The EFA requirement's objective is 'in particular to safeguard and improve biodiversity on farms'. The creation and the maintenance of EFA can be determined through the use of an EFA calculator (https://sitem.herts.ac.uk/aeru/efa/) able to compute the potential impact on the environment and in order to increase the biodiversity who is the primary EFA objective.

The three above mentioned measures are included in the "greening" strategy of the actual CAP and are warmly suggested to be included in the decisions of the project farmers. The setting up of a future voluntary market of CO2e seems a natural consequence of the adoption of this measure.

d. Cover cropping

Cover crops are primarily used in order to prevent soil erosion and nutrients leaching. Clover crop could also be used for enhancing spring snowmelt infiltration, deeper water percolation, and protect soil from temperature dramatic changes during warm and cold seasons.

e. Minimum tillage

Cultivation breaks down the stable aggregates, exposing humus in the aggregates to air and faster decomposition. Direct drill techniques allow to sow seed while leaving stubble residues on top of the soil and leaving aggregates intact. The minimum tillage soil systems are polyvalent alternatives in agriculture in order to prepare and sow. The principal effects are reduction of erosion, increasing water retention and realization of sowing in the optimal period.

f. Concentrate organic matter

An alternative to increasing inputs is to make more effective use of what is already there. Retain all organic additions, whether roots, stubble or manure close to the surface. The stability of soil structure is related to the concentration of organic matter at the surface, not the total quantity present in the soil.

g. Bio-stimulating products

Use products and bio-stimulating methods, microorganisms, rocks fine-grained materials and others products in order to support the soil ecological processes enhancing carbon stockage.

h. Integration of crop–livestock systems

Like in many parts of Europe, in Mediterranean countries the majority of farmers have specialized either in crop or animal production systems. This has created depletions of soil nutrients in the former and excess accumulations in the latter. With decreasing economic margins, higher energy and inorganic N fertilizer costs, declining soil organic matter levels, increasing concerns over the long-term sustainability of many contemporary agricultural systems, and greater regulation of agricultural practices.

In addition to the other ecological benefits, the integration of crops–livestock could provide several advantages to mitigate GHG emissions. The three main ways in which GHG emission could be mitigated by this integration are: (1) increase energy efficiency or saving of fuel (i.e. reducing distances manure and feed are transported), (2) improve N use efficiency and (3) biogas production through anaerobic digestion of manure

i. Use of compost and vermicompost

Applying organic fertilizers, such as those resulting from composting, to agricultural land could increase the amount of carbon stored in these soils and contribute significantly to the reduction of greenhouse gas emissions. Carbon sequestration in soil has been recognized by the Intergovernmental Panel on Climate Change and the European Commission as one of the possible measures through which greenhouse gas emissions can be mitigated. An estimation of the potential value of this approach -- which assumed that 20% of the surface of agricultural land in the EU could be used as a sink for carbon -- suggested it could constitute about 8.6% of the total EU emission-reduction objective. An increase of just 0.15% in organic carbon in arable soils in a country like Italy would effectively imply the sequestration of the same amount of carbon within soil that is currently released into the atmosphere in a period of one year through the use of fossil fuels.

j. Use of biochar

The incorporation of biochar in soils has two completely distinct benefits: i. the ability of biochar to store carbon in a stable form, preventing the CO2 from organic matter from leaking into the atmosphere, where it contributes to climate change. Moreover biochar ameliorates physical and chemical properties of soil, which improves food security in developing countries and crop production almost anywhere. ii. the carbon-negative capacity of biochar (reducing CO2e in the atmosphere because the production process is theoretically carbon-neutral and its cultural use increase soil organic matter).

k. Increasing the ecotones and farm biodiversity

Agroforestry is a land use management system in which trees or shrubs are grown around or among crops or pastureland. Agroforestry may contribute to GHG mitigation and biodiversity conservation in a synergistic manner which has implications for the effective allocation of resources and climate change mitigation strategies.

B. Guidelines on criteria for assessing CO2e stock/emission conditions and practices

In the following, the guidelines on defining the criteria for measuring, calculating, evaluating, implementing, and validating CO2e stock/emission conditions and practices valuable for the project are listed.

The application rules of the protocol must be simple and applicable to the various Italian and Croatian situations.

The protocol will contain:

1 - method of measuring carbon in the soil: collecting data from farmers, using European national and regional databases and if necessary (type of sampling or calculation system, soil analysis, error assessment to define the baseline).

2 - An estimation system based on scientific data about the mitigation effect of agriculture practices that will be adopted in the frame of the project, estimating net Carbon (C) balance from GHG emissions and carbon sequestration. This estimation will be realized using a Carbon Calculator Tool that can model the greenhouse gas impacts of agricultural activities in terms of carbon dioxide equivalency (CO_2e)

Technical visits to the farms will be carried out in order to assess the agronomic practices in place and the quality of the data held by the farmers.

In addition to this, the project will take into account the European data methods coming from European Soil Data Center ESDAC (https://esdac.jrc.ec.europa.eu/).

Considering objectives and limits of the project, farmers' selection will give priority to those farms already in possession of data on organic coal in soils and of measures of organic substances in soil.

If these data were not available, field evaluation methods will be built with the support of existing databases.

It will be important to develop a specific informatic tool in order to determine values and types of carbon stocked at soil level. Among them, two existing tools have been taken into consideration as possible models:

- **Ex ante estimation of the mitigation impact estimating net Carbon (C) balance from greenhouse gas (GHG) emissions and C sequestration**
  EX-Ante Carbon-balance Tool (EX-ACT) is a tool developed by the Food and Agriculture Organization of the United Nations (FAO). It is aimed at providing ex-ante estimates of the mitigation impact of agriculture, forestry and fishery development projects, estimating net Carbon (C) balance from greenhouse gas (GHG) emissions and C sequestration. EX-ACT is a land-based accounting system, measuring carbon stocks, stock changes per unit of land, and CH_4 and N_2O emissions expressed in t CO_2-e per hectare and year. The main output of the tool is an estimation of the C-balance that is associated with adoption of alternative land management options, as compared to a 'business as usual' scenario (See FAO EX -Act tool at: http://www.fao.org/fileadmin/templates/ex_act/pdf/Technical_guidelines/EX-ACT_technicaldescription_EN_v7.pdf)

- **Carbon Calculator Tool able to assess GreenHouse Gas (GHG) emissions and to formulate mitigation actions suitable for each farm**

The aim of the Carbon Calculator (CC) is to estimate the greenhouse gas (GHG) emissions from farming practices and to propose climate change mitigation actions at farm level. In that way, this tool contributes to assessing the impact of agriculture on GHG emissions and carbon sequestration. Mitigation actions are evaluated according to their GHG profile, feasibility and cost.

Effects of agricultural practices adopted will be described and measured, in relation to environmental sustainability and soil conservation and the feasibility of conservative practices and their effects on the environment, and also assessing how farmers can be encouraged, through appropriate policy measures, to adopt land conservation practices.

In any case the project, collecting existing data, will set a panel of minimum basic criteria that have to be met, in order to be used.

According with limits and features of the project, these basic standard criteria refer to the following principles:

1. Measurement of changes in organic carbon requires:

a) soil sampling strategy in order to capture the natural variation in soil carbon;

b) measure of soil organic carbon concentration;

c) estimation of the bulk density of the soil to adjust for changes in soil mass at specified depth intervals.

d) Calculation of SOC using the following formula (in t/ha):

C in t/ha = 10000 m2 in one-hectare x horizon depth in meter x bulk density in g/cm^3 x carbon percent.

2. Soil model

In order to define, at farm level, the carbon flux into the soil is important to:

1. Define soil properties and measure soil organic carbon;

2. Provide any objective way of measuring the reliability of estimates;

3. Model the soil stock.

Carbon in soil, SOC, SOM measurements and relations:

Method for determining the OM at soil level starting from the soil analysis:

Organic matter (%) = Organic C (%)*1.724

Method for the evaluation of the organic carbon in the upper soil is based on organic matter (OM) value measured

Organic C (%) = OM (%)*0.58

The assumption is that organic carbon in soil is about 58% of organic matter.

- 3. Method to evaluate the Stocked amount of Carbon in soil (SC) through an interpretation of the soil analysis: **Sc = (BD)*(h)*(T)**

Where: Sc is the C stock in soil (Mg ha-1); BD is the soil bulk density (g cm-3); h is the soil sampled depth (cm); and T is the total C concentration (g kg-1).

3. Soil properties and measure soil organic carbon: sampling

Sampling needs to capture the variability of soil organic carbon, SOC caused by different soil types within a farm, variable crop history across the farm, variable agronomy.

Typically, a minimum value of cores (bulked) within a sampling area is needed to adequately capture variability.

Farms can be zoned into several sampling areas based on soil type or properties, management history or yield potential. Position in the landscape, soil survey and farmer knowledge; land use and management history; yield maps, imagery and visual interpretation can all help determine where there is a need for soil sample. It is important to collect samples representative of the average soil condition.

Depth and time of sampling

A large amount of the organic carbon in soil is in the 0 – 10 cm layer and this is often where differences are seen. However, sampling to 30 cm provides information on changes in the location of organic carbon in soil and helps explain changes under different management practices. For example, the adoption of minimum tillage has changed the distribution of organic carbon within the soil profile - organic matter is concentrated at the soil surface and decreases at depth.

Because of this, sampling to a minimum depth of 30cm better reflects changes in carbon stocks (and is acceptable for national carbon accounts).

Time of sampling is a key factor. Soil carbon varies within season, so it is important to take soil samples at the same time each year. Sampling during the non-growing phase (that is, over summer) helps minimize the influence of plant type and growth stage on SOC, particularly in soil carbon fractions that turn over rapidly.

Calculation of organic carbon

Example:

The amount of organic carbon to 30 cm depth in soil with a carbon value of 1.5% and bulk density of 1.3g/cm3 is:

$$15 \text{ (g C/kg soil)} \times 1\,300\,000 \text{ (kg soil/ha)} = 19.5\text{t C/ha}$$

If there is gravel in the soil sample, laboratory results will need to be adjusted as this is taken out before carbon analyses.

Example: if SOC was 1.5% but soil had 25% gravel (by volume) then: 1.5 - (1.5 x 0.25) = 1.1% SOC

C. Guidelines on setting up a voluntary carbon market

This paragraph explains the generation/transaction, suggested principles and procedures for a development of a carbon market, core of the GECO2 project.

The market consists of a platform where carbon credits are traded. Within the platform, public and private subjects can interact, selling carbon credits (generated by agricultural practices) and subjects who intend to purchase them to offset their emissions (manufacturing industries, small and medium-sized companies, service company, multi-utility, farmers) from cradle to gate. The interactions between supply and demand is managed, in this experimental phase, by the project. The project will provide information on the commitments that each party must underwrite and on the different stages in which the purchase and sale of credits is organized. The project will also carry out a series of support activities for market development, dedicated to both sellers and buyers, including the updating of a specific public "register" (Observatory).

The Observatories, therefore, play the role of registering actors and transactions, giving publicity and transparency to the functioning of the market.

Actors, Temporal scope and Additionality

The main players in the market are credit buyers and sellers. “Carbon crediting” refers to the process of issuing a credit for one tCO2e that meets the criteria of the crediting scheme in question. Carbon offsetting” refers to the use of carbon credits to compensate for an equivalent amount of emissions.

Most carbon crediting mechanisms set limits on crediting periods. For example, for CDM projects the crediting period can be either 10 years non-renewable or 7 years with the option to renew up to two times for a total maximum of 21 years; for forestry activities these periods are 30 years and 20 years renewable twice, respectively. The Gold Standard offers a five-year renewable certification cycle, while the VCS offers 10-year crediting periods, renewable up to two times for non-AFOLU projects. Other standards also typically offer crediting periods between 5 and 10 years with a notable exception of forestry projects that may have significantly longer crediting periods, e.g. up to 100 years under the VCS and CAR. GECO2 offers a credit period of one year.

Baseline usually refers to a scenario that reasonably represents anthropogenic GHG emissions that would most likely have occurred in the absence of the project. There are different approaches in setting baseline emissions, mainly between standardized and project-based baselines, with all offset programmes using standardized approaches to some extent.

Additionality ensures that only those projects that would not have happened anyway should be eligible to receive carbon credits. Similar to setting baseline emissions, determining additionality under carbon crediting schemes requires consideration of the respective country’s circumstances.

Farmers CO2e absorbers (sellers)

Credit sellers can be farmers, who adopt measures aimed at promoting carbon sequestration. Carbon crediting mechanisms usually require validation of the project activities before registration and verification of emission reductions achieved by the project. The GECO2 methodology, the project's baseline and monitoring plan, and compliance with relevant ISO 14064-2 criteria are validated and verified in order to confirm that the project design and implementation, as documented, is sound and reasonable and meets the identified criteria. Validation and verification is necessary to provide assurance to stakeholders of the quality of the project and its intended generation of the Verified Emission Reductions (VERs).

The project, through its protocols (Guidelines for agricultural protocols definition with reference to the main rural sectors and Guidelines on defining the criteria for calculating evaluating, implementing, and validating CO2e stock/emission conditions and practices), will establish essential principles on which conditions of participation and impact on credit calculation will be based.

CO2e emitters (buyers)

Credit purchasers can be farmers with transforming activities, small and medium-sized industrial enterprises, multi-utilities and service companies (in particular cases, also local public bodies).

Structures of market management

GeCO2 project management will act as auditing market validation and verification body: at the present stage, no provision is made for an independent third party certificating the credits generated and the emission inventories.

It is vital to develop tools that will be used for the proper functioning of transactions, including purchasing and selling contracts, mechanisms for joining and participating in the market, checking and quality procedures. Furthermore, within the market, each partner, through its observatory in its project region, will be responsible for establishing the firms and credit register and its continuous updating, as well as for helping local and project management to constantly monitor credit transactions.

Geco2 project management, with the support of Scientific Committee, will have the following functions:

- Evaluate the possibility of establishing a carbon market…
- Define the possibility to sell carbon credits that are allowed by the EU regulations
- validate the new market and ensure the matching with project objectives and planned activities;
- approve the definition of the database and provide coordination among regional databases;
- validate the new market and ensure the matchmaking with the project objectives and requisites;
- approve and supervise application of the protocols(calculation of credits and sustainable methods of cultivation);
- supervise the functioning of the market according to the project rules:
- control the respect of the actors ‘engagements.

Market rules

Credit generation and validation process

The market considers the credits generated by the following types of projects: sustainable agricultural practices.

Eligible activities for the generation of carbon credits are foreseen in farm Protocol and specified in calculation system methodologies

It is possible to introduce different activities from those which were originally foreseen and to develop innovative aspects, but always within the areas of intervention originally planned by the project.

All the eligible activities must respect the principles of additionality, permanence and baseline. To account for the project’s non-permanence risk, the project’s project buffer rating (or overall risk rating) is estimated by using the calculation system.

It is important to define clearly and unambiguously the baseline or the reference scenario for all eligible activities for the generation of carbon credits. The baseline identified must be approved by the project.

Pricing mechanism

The definition of prices will be defined in the protocol and it will be linked on existing market experiences related to trade carbon credits deriving from Kyoto agreement and proposed schemes. However, the pricing mechanism will be adapted to the peculiar characteristics of GECO2.

Matchmaking functioning mechanism and management

Roles of the actors (buyers and sellers) adopt different methods of joining the market.

Buyer commitments

1. comply with the regulations relating to participating companies in administrative and environmental issues;

2. carry out a quantification of the company GHG emissions or at the supply chain level (LCA) at least for a production line;

3. activate its own environmental policy that integrates the compensation action, activating a medium-term strategy (5 years), aimed at reducing or controlling its emissions;

4. sign the commitment to accept the conditions of the market;

5. proceed with the purchase of the CO2 quotas by signing a purchase contract;

6. transfer the obligations connected to the contract also to the new owner, in the case of transfer of all or part of the company property;

7. facilitate access to the company and the data necessary for checks (information relating to energy consumption in order to estimate the equivalent CO2 emissions);

8. do not resell the credits purchased to other subjects (whether or not they are members of the market);

9. use the market logo, as established by the protocol and manual, and make a correct and clear communication of the compensation activity carried out with the project.

Sellers commitments

1. respect the requirements of the protocol, that determine the quantification of carbon credits;

2. transfer the obligations associated with the sale of CO2 (thirty-year stay) to the new owner, in the case of the sale of all or part of the property that generates the credits;

3. undergo an audit by GECO2 Management as a guarantee to the system (which implies the verification of the surfaces, the uses, etc.);

4. facilitate access to the property and the data necessary for the checks (information relating to the property that generates the credits);

5. not to sell the credits already purchased to other parties or not to the market.

Buyer rights

Exploit the purchase of the credits in order to organize a communication campaign showing that the company products are CO2e free, because of the realized offset.

In this frame the buyer will have the right to freely use the project logo.

Specific terms and conditions for the right to use the project logo must be outlined, in order to prevent misuse, such as regularly registering the brand as an individual trademark. Whoever wants to use the brand must therefore respect the rules of use of the logo.

Furthermore, buyers will exploit communication tools and events organized by the project.

Sellers rights

- to be assisted by the project in the implementation of the environmental measures and practices adopted by the farmers;
- to organize a communication campaign showing that the farm has participated to the project;
- to exploit the communication campaign organized by the project.

Other market functioning mechanisms

Registration

It is mandatory to establish a Register where all credit transactions carried out are recorded, in order to ensure transparency and to prevent credits from being sold more than once.

Quality assurance procedures

The project will organize periodic controls in participating actors in order to check the respect of the established market and technical conditions.

D. Guidelines on contract to be signed by farmers and buyers

A simple form of agreement stating farmers obligations, farmers rights and terms of the economic transaction of the credits has to be prepared.

Simple and short text resuming farmers commitment, timing, controlling procedures.

In addition to that, the proposed contract will define project responsibility, and its external role as matchmaking body, on selling CO2e credits and establish procedures and timing of the process.

A special attention will be paid to transparency and publicity rules.

On the other hand a contract model with the same characteristics of the farmers contract will be prepared for the buyers in order to properly define credits purchasing.

E. Guidelines for development of observatory database

The GECO2 database will integrate data from the seven partner regions, each partner will have access to his own data. At the end of the project data will be replicated in seven regional databases for further developments.

A remote interface to the database will record the demand and supply of carbon credits in the project selected sectors, ensuring the transparency of transactions and withdrawal of credits from the market once they have been sold.

Databases may also have the task of monitoring the credits for the whole period of their duration (X years) and to verify the existence of the conditions signed at the time of joining the market.

Database will have the function to act as a public register, recording market transactions, in order to create market constant traceability and assure transparency to the management model.

The database will also play a pilot role in building in the future an observatory measuring regional CO_2 emissions and absorption.

Software basic topics:

- free relational database management system (RDBMS, foreseen PostgreSQL);
- open source remote interface to manage the database (Python or C++);

Requested features:

- user policy (the user will access to his own data and shared data);
- transactions management;
- concurrent access;
- georeferenced data;
- redundancy/safety backups;
- user friendly interface;
- potential development in order to be transformed in the future in a more secure system.

ANNEX 1 – Glossary and definitions

For the purposes of the project cultivation Protocol:

Sustainable agriculture management means the stewardship and use of rural lands in a way, and at a rate, that increase organic carbon stocks, regenerate soil organic carbon, maintains their biodiversity, productivity, vitality and regeneration capacity, and their potential to fulfill relevant ecological, economic and social functions at local, national, and global levels, and that does not cause damage to other ecosystems;

Soil recovering agriculture means a system of soil management which provides continuous restoration, development, and treatment of stands similar in soil structure, composition and species diversity and dynamic to natural soils specific for the site conditions.

Soil organic carbon (SOC) is the main constituent of soil organic matter, accounting for 50% of the total, and sequestration of carbon (C) in soils plays a vital role in removing CO2 from the atmosphere. There are a whole range of SOC levels in different soils. For the surface soils, SOC ranges from about 10% in the alpine soils to less than 0.5% in the desert soils. In the Adriatic regions, SOC is estimated to be about 3-5% in grazing systems and 2-3% in cropping systems

Soil organic matter (SOM) is the organic matter component of soil, consisting of plant and animal detritus at various stages of decomposition, cells and tissues of soil microbes, and substances that soil microbes synthesize. SOM provides numerous benefits to the physical and chemical properties of soil and its capacity to provide regulatory ecosystem services.

Carbon sequestration (CS) is the long- term storage of carbon in oceans, soils, vegetation (especially forests), and geologic formations. Although oceans store most of the Earth's carbon, soils contain approximately 75% of the carbon pool on land — three times more than the amount stored in living plants and animals. Therefore, soils play a major role in maintaining a balanced global carbon cycle.

Conservation tillage (CT) minimizes or eliminates manipulation of the soil for crop production. It includes the practice of mulch tillage, which leaves crop residues on the soil surface. These procedures generally reduce soil erosion, improve water use efficiency, and increase carbon concentrations in the topsoil. Conservation tillage can also reduce the amount of fossil fuel consumed by farm operations. It has been estimated to have the potential to sequester a significant amount of CO2.

Cover cropping is the use of crops such as clover and small grains for protection and soil improvement between periods of regular crop production. Cover crops improve carbon sequestration by enhancing soil structure and adding organic matter to the soil.

Crop rotation is a sequence of crops grown in regularly recurring succession on the same area of land. It mimics the diversity of natural ecosystems more closely than intensive mono-cropping practices. Varying the type of crops grown can increase the level of soil organic matter. However, effectiveness of crop rotation depends on the type of crops and crop rotation times.

Decomposition and SOC occurs when microorganisms use SOC in soil to obtain the carbon, nutrients and energy they need to live. During decomposition, SOC is lost from soil because microorganisms convert about half of the SOC to carbon dioxide gas (CO_2). Without continual inputs of SOC, the amount stored in soil will decrease over time because SOC is always being decomposed by microorganisms.

Erosion of surface soil and SOC: Losses of SOC from erosion of surface soil can have a large impact on the amount of SOC stored in soil. This is because organic carbon (OC) is concentrated in the surface soil layer as small particles that are easily eroded. In agriculture erosion can cause the annual loss of 0.2 t/ha of soil from a pasture, 8 t/ha from a crop and up to 80 t/ha from bare fallow. Off-take of OC in plant and animal production is also an important loss of OC from soil. Harvested materials such as grain, hay, feed and animal grazing all represent loss of OC (and nutrients) from soil.

Natural rural ecotones are rural edges composed by trees and shrubs autochthonous (or typical in the area) species with most of the principal characteristics and key elements of native ecosystems, such as complexity, structure and diversity;

Vermicompost is the product of the decomposition process using various species of worms, usually red wigglers, white worms, and other earthworms, to create a mixture of decomposing vegetable or food waste, bedding materials, and vermicompost.

Biochar is a charcoal-like substance that is made by thermal degradation of organic material from agricultural and forestry wastes (also called biomass) in a controlled process called pyrolysis. Although it looks a lot like common charcoal, biochar is produced using a specific process to reduce contamination and safely store carbon.

Ecological network means a system of areas which are ecologically and physically linked, consisting of core areas, corridors and buffer zones.

Bio activators are defined as “Plant bio stimulants contain substance(s) and/or micro-organisms whose function when applied to plants or the rhizosphere is to stimulate natural processes to enhance/benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, and crop quality.”

greenhouse gas source, GHG source

process that releases a GHG into the atmosphere

greenhouse gas sink, GHG sink

process that removes a GHG from the atmosphere

greenhouse gas reservoir, GHG reservoir

component, other than the atmosphere, that has the capacity to accumulate GHGs, and to store and release them

Note 1 to entry: Oceans, soils and forests are examples of components that can act as reservoirs.

Note 2 to entry: GHG capture and storage is one of the processes that results in a GHG reservoir.

greenhouse gas emission, GHG emission

release of a GHG into the atmosphere

greenhouse gas removal, GHG removal

withdrawal of a GHG from the atmosphere by GHG sinks

greenhouse gas emission factor, GHG emission factor

coefficient relating GHG activity data with the GHG emission

Note 1 to entry: A GHG emission factor could include an oxidation component.

greenhouse gas removal factor, GHG removal factor

coefficient relating GHG activity data with the GHG removal

Note 1 to entry: A GHG removal factor could include an oxidation component.

direct greenhouse gas emission, direct GHG emission

GHG emission from GHG sources owned or controlled by the organization

Note 1 to entry: This document uses the concepts of equity share or control (financial or operational control) to establish organizational boundaries.

direct greenhouse gas removal. direct GHG removal

GHG removal (3.1.6) from GHG sinks owned or controlled by the organization

indirect greenhouse gas emission, indirect GHG emission

GHG emission that is a consequence of an organization's (operations and activities, but that arises from GHG sources that are not owned or controlled by the organization

Note 1 to entry: These emissions occur generally in the upstream and/or downstream chain. Global warming potential, GWP index, based on radiative properties of GHGs, measuring the radiative forcing following a pulse emission of a unit mass of a given GHG in the present-day atmosphere integrated over a chosen time horizon, relative to that of carbon dioxide (CO_2)

carbon dioxide equivalent CO_2e unit for comparing the radiative forcing of a GHG to that of carbon dioxide

Note 1 to entry: The carbon dioxide equivalent is calculated using the mass of a given GHG multiplied by its global warming potential.

Terms relating to the GHG inventory process, definitions (© ISO 2018, source: ISO 14064-1:2018)

greenhouse gas activity data, GHG activity data: quantitative measure of activity that results in a GHG emission or in a GHG removal

EXAMPLE Amount of energy, fuels or electricity consumed, material produced, service provided, area of land affected.

primary data: quantified value of a process or an activity obtained from a direct measurement or a calculation based on direct measurements.

Note 1 to entry: Primary data can include GHG emission factors or GHG removal factors and/or GHG activity data.

site-specific data: primary data obtained within the organizational boundary

Note 1 to entry: All site-specific data are primary data, but not all primary data are site-specific data.

secondary data: data obtained from sources other than primary data

Note 1 to entry: Such sources can include databases and published literature validated by competent authorities.

GHG statement DEPRECATED: GHG assertion factual and objective declaration that provides the subject matter for the verification or validation

Note 1 to entry: The GHG statement could be presented at a point in time or could cover a period of time.

Note 2 to entry: The GHG statement provided by the responsible party (3.4.3) should be clearly identifiable, capable of consistent evaluation or measurement against suitable criteria by a verifier (3.4.11) or validator (3.4.12).

Note 3 to entry: The GHG statement could be provided in a GHG report (3.2.9) or GHG project (3.2.7) plan.

ANNEX 2 – Carbon environmental labels

ISO 14020:2000, Environmental labels and declarations —This International Standard establishes guiding principles for the development and use of environmental labels and declarations. It is intended that other applicable standards in the ISO 14020 series be used in conjunction with this International Standard.

ISO 14021:2016, Environmental labels and declarations — Self-declared environmental claims (Type II environmental labeling). This International Standard specifies requirements for self-declared environmental claims, including statements, symbols and graphics, regarding products. It further describes selected terms commonly used in environmental claims and gives qualifications for their use. This International Standard also describes a general evaluation and verification methodology for self-declared environmental claims and specific evaluation and verification methods for the selected claims in this International Standard.

ISO 14024:2018, Environmental labels and declarations — Type I environmental labeling — Principles and procedures. This International Standard establishes the principles and procedures for developing Type I environmental labeling programmes, including the selection of product categories, product environmental criteria and product function characteristics, and for assessing and demonstrating compliance. ISO 14024:2018 also establishes the certification procedures for awarding the label.

ISO 14025:2006, Environmental labels and declarations — Type III environmental declarations — Principles and procedures. This International Standard establishes the principles and specifies the procedures for developing Type III environmental declaration programmes and Type III environmental declarations. It specifically establishes the use of the ISO 14040 series of standards in the development of Type III environmental declaration programmes and Type III environmental declarations.

ISO 14025:2006 establishes principles for the use of environmental information, in addition to those given in ISO 14020:2000.

Type III environmental declarations as described in ISO 14025:2006 are primarily intended for use in business-to-business communication, but their use in business-to-consumer communication under certain conditions is not precluded.

ISO 14040:2006. Environmental management — Life cycle assessment — Principles and framework. ISO 14040:2006 describes the principles and framework for life cycle assessment (LCA) including: definition of the goal and scope of the LCA, the life cycle inventory (LCI) analysis phase, the life cycle impact assessment (LCIA) phase, the life cycle interpretation phase, reporting and critical review of the LCA, limitations of the LCA, the relationship between the LCA phases, and conditions for use of value choices and optional elements. The document covers LCA studies and LCI studies. It does not describe the LCA technique in detail, nor does it specify methodologies for the individual phases of the LCA.

The intended application of LCA or LCI results is considered during definition of the goal and scope, but the application itself is outside the scope of this International Standard.

ISO 14064-1:2018, Greenhouse gasses — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas (GHG) emissions and removals.

This document specifies principles and requirements at the organization level for the quantification and reporting of GHG emissions and removals. It includes requirements for the design, development, management, reporting and verification of an organization's GHG inventory.

The ISO 14064 series is GHG programme neutral. If a GHG programme is applicable, requirements of that GHG programme are additional to the requirements of the ISO 14064 series.

ISO 14064-2:2019. Greenhouse gasses — Part 2: Specification with guidance at the project level for quantification, monitoring and reporting of greenhouse gas emission reductions or removal enhancements. This document specifies principles and requirements and provides guidance at the project level for the quantification, monitoring and reporting of activities intended to cause GHG emission reductions or removal enhancements. It includes requirements for planning a GHG project, identifying and selecting GHG sources, sinks and reservoirs (SSRs) relevant to the project and baseline scenario, monitoring, quantifying, documenting and reporting GHG project performance and managing data quality.

ISO 14064-3:2019. Greenhouse gasses — Part 3: Specification with guidance for the verification and validation of greenhouse gas statements. This document specifies principles and requirements and provides guidance for verifying and validating GHG statements. It is applicable to organization, project and product GHG statements.

ISO 14067:2018 Greenhouse gasses — Carbon footprint of products — Requirements and guidelines for quantification. This document specifies principles, requirements and guidelines for the quantification and reporting of the carbon footprint of a product (CFP), in a manner consistent with International Standards on LCA (ISO 14040 and ISO 14044).

Requirements and guidelines for the quantification of a partial CFP are also specified.

This document is applicable to CFP studies, the results of which provide the basis for different applications.

This document addresses only a single impact category: climate change. Carbon offsetting and communication of CFP or partial CFP information are outside the scope of this document.

This document does not assess any social or economic aspects or impacts, or any other environmental aspects and related impacts potentially arising from the life cycle of a product.

Italian Standard. Uni 11646:2016 "Gas ad effetto serra – Specifiche per la realizzazione del sistema nazionale di gestione del mercato volontario dei crediti di CO2 e derivanti da progetti di riduzione delle emissioni o di aumento delle rimozioni di GHG".

Terms relating to greenhouse gasses, definitions (© ISO 2018, source: ISO 14064-1:2018)

greenhouse gas, GHG

gaseous constituent of the atmosphere, both natural and anthropogenic, that absorbs and emits radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds

Note 1 to entry: For a list of GHGs, see the latest Intergovernmental Panel on Climate Change (IPCC) Assessment Report.

Note 2 to entry: Water vapor and ozone are anthropogenic as well as natural GHGs, but are not included as recognized GHGs due to difficulties, in most cases, in isolating the human-induced component of global warming attributable to their presence in the atmosphere.