# Work package 5:

# Net ecosystem $CO_2$ exchange of landscapes

**Aim**

The goal of WP5 is to evaluate the annual carbon balances for landscape sections of approx. 100 $km^2$ size, examining the trends in land-use change observed for alpine regions in the context of scenarios.

**Deliverables**

* Spatial database for landscape models
* Development and adaptation of a landscape modelling software
* Simulations of landscape carbon balances for current and projected future land use in selected study sites
* Testing and application of novel remote sensing technique (ASPIS) in selected study sites

| No. | Work description |
|---|---|
| 1 | Model theory: A one-dimensional, stratified core model for grassland vegetation stands as described in WP 4 will be inserted into a spatial framework that allows an evaluation of annual carbon and water balances for landscapes. The landscape model will be process-based and, thus, allow for scenarios that include different vegetation types and differences in treatment or management of mountain ecosystems. |
| 2 | GIS data base: The GIS data base represents the necessary input data for scaling up NEE to the landscape level. In each of the four areas a GIS data base will be elaborated and carbon flux data inputs to the modelling will include results from other national and EU programmes as well as CARBOMONT. The GIS data base should consist of spatial maps of: vegetation distribution, plant cover, plant area index, soil type, and digital elevation (DEM). For the target landscapes the GIS data bases are largely extant, missing/additional data will be acquired, in part by remote sensing (partner team no. 5, UNITUS). The data bases will be stored at the team which has acquired it, but will be made available to other teams in need of this data for the up-scaling process, in particular partner team no. 2 (UBT). Pixel size can vary from 30 to 100 m, depending on assumptions that can be made regarding homogeneity in ecosystem function. |
| 3 | Remote sensing: The spatial information will also be supported by multi-spectral aircraft based remote sensing data (ASPIS) which will provide high resolution mapping of NDVI, red edge characteristics, and LAI. The flights will be carried out in 3 project study areas : Appennine site (year 1-3, 6 flight hours per year), Lavarone (year 2, 10 flight hours) and Stubai Valley (year 2, 10 flight hours). |
| 4 | Model application: Within the target landscapes (Berchtesgaden, Stubai Valley, Lavarone, Appennine and Värriö) carbon balances will be related to trends in land-use change resulting from contrasting policy scenarios. |

**Detailed assessment of the contribution of each partner team to the work description above, separately for each of the 23 study sites:**

| | UIBK | | | | | UBT | | UNITUS | | CEA | | CEH | | ULUND | | UHEL | | CEAM | | LAC | | SIRG | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | A2 | A3 | A4 | A5 | G1 | G2 | I1 | I2 | I3 | I4 | UK1 | UK2 | S1 | S2 | F1 | F2 | E1 | E2 | CH1 | CH2 | CH1 | CH2 |
| 1 | - | | | | | v | | - | | - | | - | | - | | - | | - | | - | | - | |
| 2 | v | | | | | v | | v | | v | | - | | - | | v | | - | | - | | - | |
| 3 | 3 | | | | | - | | v | | 3 | | - | | - | | - | | - | | - | | - | |
| 4 | v , 2 | | | | | v | | v , 2 | | v , 2 | | - | | - | | v , 2 | | - | | - | | - | |

## Approach and Methodology

General approach:  WP5 is intended as a first step in generalizing the results of NEE measurements at intensive study sites of CARBOMONT. Inherent in the philosophy of WP5 is the question whether current approaches that presume to describe regional to global carbon balances of ecosystems through model applications with coarse scale grids are able in fact to capture and up-scale (average) the dynamics and differentiation in vegetation to atmosphere exchange that occurs. Thus, the size of landscape sections in WP5 is kept relatively small (a size that investigators can examine and characterize in detail) and the focus is on assessing in a comparative way the function of ecosystems that occur in adjacent locations. While CARBOMONT provides very good information on grassland ecosystem function at the study sites that is quantified in the modelling of site specific NEE in WP4, the purpose of WP5 is to put this information into a spatial context as well as to contrast the results with information that has been gained about other types of ecotopes in the general vicinity (perhaps even on the same soils).

Required data:  Information required in WP5 are those that allow simulations with a SVAT model (see protocol for WP4) for what are viewed as important and essential ecotopes included within the selected landscape section. Furthermore, these ecotope-specific SVAT model simulations should be possible at any chosen location of the selected landscape. This leads to the organization of the following data bases at sites chosen to estimate landscape NEE and with scenarios of land cover change:

* Physiological response of leaves of species dominating structure of essential ecotopes
* Respiration response of leaves, woody plant materials, and soils
* Digital elevation model as raster file, vertical resolution as needed to reflect
* topographic influences on driver variables determining NEE and ET
* Land cover as arcinfo or raster file geo-referenced to DEM
* Meteorological data for long periods (radiation, temperature, humidity, wind, rainfall)
* at as many locations as possible within the selected landscape section

Analysis steps:

(1) Use of physiological response and respiration data to derive SVAT model parameters, if possible as a function of environmental gradients within the study area

(2) Derivation of spatial set of meteorological drivers, interpolating between meteorological stations

(3) Simulations based on land cover spatial data and DEM

(4) Examination of potential feedback coupling within the study area that might strongly modify landscape NEE response, e.g., hydrological flows, soil development, air circulation, etc.

(5) Examination of the influences of landscape simplification on presumed non-linear landscape response, e.g., up-scaling in the sense that pixel size is reduced and elimination of specific physiological types

| **Input data as indicated for WP4 (spatially distributed)**<br>**Model outputs as spatial fields for hourly, daily, monthly and annual periods** |
|---|
| Net ecosystem CO2 exchange (µmol $m^{-2}$ $h^{-1}$) |
| Canopy photosynthesis (µmol $m^{-2}$ $h^{-1}$) |
| Leaf respiration (µmol $m^{-2}$ $h^{-1}$) |
| Woody aboveground respiration (µmol $m^{-2}$ $h^{-1}$) |
| Soil respiration (µmol $m^{-2}$ $h^{-1}$) |
| Evapotranspiration rate (mmol $m^{-2}$ $h^{-1}$), (W $m^{-2}$) |
| Evaporation from canopy store (mmol $m^{-2}$ $h^{-1}$), (W $m^{-2}$) |
| Transpiration rate (mmol $m^{-2}$ $h^{-1}$), (W $m^{-2}$) |
| Soil evaporation (mmol $m^{-2}$ $h^{-1}$), (W $m^{-2}$) |
| PAR (µmol $m^{-2}$ $h^{-1}$) absorbed by canopy and soil surface |
| Soil water content ($m^3$ $m^{-3}$) and matric potential (Pa) |