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Environmental Life Cycle Assessment Model for Soil Bioengineering Measures on Infrastructure Slopes

Stephan Hoerbinger (1,2) and Michael Obriejetan (1,2)

(1) alpS – Centre for Climate Change Adaptation, Innsbruck, Austria (hoerbinger@alps-gmbh.com), (2) Institute of Soil Bioengineering and Landscape Construction, University of Natural Resources and Life Science, Vienna, Austria

Soil bioengineering techniques can be a helpful instrument for civil engineers taking into account not only technical but also ecological, socio-economic and sustainability aspects. Environmental Life Cycle Assessment (LCA) models can serve as supplementary evaluation methods to economic analyses, taking into account the resource demand and environmental burdens of engineering structures. The presented LCA model includes the functional grade of structures in addition to environmental aspects.

When using vegetation as living construction material, several factors have to be considered. There is the provision of ecosystem services of plants, such as the stabilization of the slope through its root-system, CO_2 sequestration through biomass production et cetera. However, it must be noted that vegetation can cause security issues on infrastructure facilities and entail costs through the necessity of maintenance works. For this reason, it is necessary to already define the target systems during the planning phase of a soil bioengineering structure. In this way, necessary measures can be adapted in all life cycles of a structure. The objective of the presented LCA model is to serve as a basis for the definition of target systems.

In the designed LCA model the soil bioengineering structures are divided into four life phases; construction phase, operational phase, end of life phase and subsequent use phase. A main objective of the LCA model is the understanding of the “Cumulative Energy Demand” (CED) and “Global Warming Potential” (GWP) of soil bioengineering structures during all life cycle phases. Additionally, the biomass production and the CO_2 sequestration potential of the used plants are regarded as well as the functional integrity of the soil bioengineering system.

In the life phase of soil bioengineering structures, a major part of the energy input is required during the construction phase. This is mainly due to the cumulative energy demand of the inert materials used. The principle of biological engineering constructions is based on the combination of dead and living materials and the emerging positive synergistic effects. The dead auxiliaries (stone, wood, etc.) protect the living plants until they undertake technical functions. During the operational phase of the structure, maintenance work has to be done in order to maintain the protective properties of the used plants. Through measures like cutting the vegetation back to the trunk, energy will be put into the system (e.g. through machine use), but will also be put out in form of biomass. Additionally, carbon is sequestered by the biomass production of the plants. The end of life phase is reached after the projected lifetime of a structure. Outside of zones with plant growth restrictions like within a clearance gauge, soil bioengineering approaches are designed to have a subsequent use phase. That means, that after the actual lifespan of the construction, a forest should have developed and maintain its balance by natural succession. The LCA model aims at supporting sustainable management strategies for CED and GWP as a base for Green Public Procurement and eco- friendly implementation and maintenance of soil bioengineering structures on infrastructure slopes.