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FORMIA



UNIVERSIDADE DE ÉVORA



Output 3.2

ECOMED Protocol 2  
Bioengineering work analysis protocol

**ECOMED - Ecoengineering in  
the Mediterranean Environment**

**ECOMED Protocol 2**

**BIOENGINEERING WORK  
ANALYSIS PROTOCOL  
TEMPLATE**

*Edited By: Guillermo Tardio*

**Summerize Info**

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Project title

**ECOMED**

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WP reference

**WP3 Development of sector specific routines and curricula**

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Task reference

**Task 3.1 and 3.2**

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Date

**30/05/2017**

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Document version / status

**Final v.1.2**

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This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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## 1. THE AIM OF THIS PROTOCOL

- This Protocol 2 is about defining the existing project information and the set of variables to be measured in the eco-engineering work analysis and field work. For the generation of the bioengineering work analysis report, please follow the below sections and questions.

## 2. GENERAL INFORMATION ABOUT THE PROJECT AND THE CONSTRUCTION SITE

Please, provide in your analysis the following information with your remarks:

- Work location / project title:
- UTM coordinates: In case of river works, explain the characteristics of flood events that had affected the job site (data, Flow rate, equivalent return period, speeds and shear boundary stress).
- Completion date of the design stage:
- Completion date of the construction stage:
- Client: (e.g. private or public person or industrial company)
- Decision criteria for this type of construction: (e.g. ecological restoration; prevention; erosion control; landslide to restore;.....)
- Your opinion in describing the result of the work, in terms of the pursued objectives, is:
  - Successful evolution of the work (all the main objectives were achieved) during 1 to 2 or 3 years after completion
  - Still successful evolution of the work (all the main objectives were achieved) after more than 5 years after completion
  - Acceptable evolution and results (the main objectives were partially achieved) after more than five years after completion
  - Failure during 2 or 3 years after completion: slope failure, erosion problems, etc.
  - Failure after more than 5 years after completion: slope failure, erosion problems, etc.
  - Etc.

Please give your opinion about disturbing elements present between the design stage and the construction stage:

- Not enough budget
- Construction stage too short
- Lack of a competent (effective) supervision during the construction stage
- Lack of and affective monitoring stage after the construction stage
- Etc.

Please, indicate the construction standards used in the work:

Please, indicate the kind/type of insurance applied for designer/construction company, write NONE when no insurance applied: .....

### 3. INFORMATION RELATED TO THE ANALYSIS WITHIN THE PROJECT

In this stage we are looking for information regarding the project and the way the work was done.

In this section, the questions are structured into two different levels:

Level 1: What information was considered and collected for doing the project.

Level 2: What was calculated and included within the project?

#### 3.1 Level 1. What information was considered and collected for doing the project?

The information we are seeking here is: What was done by the soil- and water- bioengineer during the analysis stage and before the beginning of the designing stage? Here we will analyse all the preliminary analyses and studies related to the site carried out before proposing concrete solutions into the project.

This preliminary analysis stage occurs before the planning/design stage and includes researching and collecting all kind of information available related to the site. Examples of this are the following:

- Project key objectives? (Erosion control, slope stability, habitat restoration -for species-, landscape restoration,..).
- Site reconnaissance, desk studies, and inspections for biodiversity, dendrology, inspections for ecology
- Native vegetation analysis
- Landscape features
- Problems, risks and hazards that were addressed by the project
- Visual soil/rock classification. Geotechnical analysis (preliminary assessment of ground/slope stability, etc.)
- Hydraulic/hydrographic analysis
- In case of river works, the characteristics of flood events that had affected the job site (data, Flow rate, equivalent return period, speeds and shear boundary stress)
- Maps, photographs with the purpose of collecting historical information
- Site topography
- Cadastral data, parcel ownership.
- Interviewing people for collecting historical information
- Collection of urban planning processes and information showing current or future impacts with the work/site
- Other construction sites planned close to the site
- Calculations and drawings related to this preliminary stage
- Existing information in Regulatory Agencies
- Etc.

#### 3.2 Level 2. What was calculated and included into the project?

In this level the planning/designing stage established by the soil- and water- bioengineer is analysed. This stage follows the preliminary analysis stage (analysed in the preceding level 1). The design documents and information (the project itself) are now to be analysed and assessed.

Some examples of the type of information analysed in his level are the following:

- **Materials selection and specification** (timber, plant species-native or exotic species, plantation techniques, stored topsoil, compost, seeds, rocks, soils/fill, geosynthetics, other materials, etc.).
- **Calculations, models, and drawings** related to obtain accurate designing documents, including all relevant input parameters for the calculations

- **Justification of the bioengineering techniques selection** – which engineering problem(s) has been solved
- **Which aspects are improvable at the design stage?**
- Etc.



## 4. INFORMATION TO ANALYSE THE WORK THROUGHOUT ITS CONSTRUCTION AND ITS SERVICE LIFE

In this section the work will be analysed throughout its service life. We will have the following levels of analysis:

Level 1: Construction stage analysis

Level 2: Maintenance and monitoring stage analysis

Level 3: Current state of the bioengineering work

Level 4: (optional) Decommissioning.

### 4.1 Level 1. Construction stage analysis (Construction Company's work!)

The question to answer here is: how was the work carried out by the contractor (Construction Company) during the construction stage?

The construction stage corresponds to the construction of the client's project by a contractor (construction company) based on design documents approved by the client. Examples of the issues to be analysed here are the following:

#### General issues, problems and defects.

- Problems/defects/issues recorded during the construction stage (information retrieved from the construction company).
- Detected flaws regarding the construction stage. E.g.
  - increasing bed or river bank erosion in upstream or downstream areas adjacent to the work,
  - Incorrect harvest method and transport conditions of the living material
  - Incorrect use and placement of the living material,
  - Incorrect storage conditions of the living material
  - etc.

#### Issues related to construction features:

- Where there any plantation techniques used to better attain and/or preserve soil humidity? (E.g. tree pit formation, mulching, etc.).
- Was there any mycorrhizae used in the utilised plants?
- Were there any quality control for materials, plants (quality and origin) used in the work? If so, which normative (standard) was followed?
- Information regarding quality control for the inert materials (grey materials). Related normative (standard).
- Information regarding quality controls for the living material (vegetation, stakes, seeds, live branches, etc.). Related normative (standard).
- Were there any hormone treatment used for improving plant rooting capacity and root system development? Related normative (standard).
- Plant density. In case herbaceous species: seeding rate.
- Bad connections/junctions between the logs,
- Bad lateral connection of the work with the slope in its extremes,
- Insufficient or missing soil compaction
- Adverse climate conditions
- Etc.

### Miscellaneous:

- Information regarding the qualification documents of the construction company in the field of soil- and water-bioengineering techniques?
- Qualifications and sufficient number of the workforce employed (in terms of workforce capacity to finish the work within the decided schedule and reaching the pursued quality standards)?
- Were there any adherent polluting matters or residues on inherent construction material?
- Groundwater appearance?
- Sanitation failure?
- Natural landslide impact?
- Destruction by local residents observed?

### 4.2 Level 2. Maintenance and monitoring stage analysis

Please, provide information regarding the bioengineering work monitoring and maintenance tasks carried out.

- Was there a maintenance contract?
- Comparison between specification/design and 'as built' measure
- Information on any maintenance work during monitoring phase. If applicable, characterisation of the maintenance tasks in terms of their performance and suitability
- Analyse all the available information regarding the bioengineering work monitoring tasks carried out
- Etc.

### 4.3 Level 3. Analysis of the current state of the bioengineering work

This level is directly related to the field work protocol (protocol 3). In this level we will analyse the data related to the operation stage (or work service life stage) of the work. This is the stage in which the construction site field work takes place.

The following sections will be included in this analysis:

1. Current state of working area
2. Current state of reference scenarios (see protocol 3 and construction site analysis report template for their definitions)
3. In situ field work variables analysis.

#### 4.3.1 Current state of working area

Analysis of the current state of the bioengineering work:

- Stability: as expected; signs of failure but stable; undesirable problem
- Durability: as expected; signs of failure but stable; undesirable problem
- Ageing: as expected; signs of failure but stable; undesirable problem
- Deterioration: no signs of failure; as expected
- State of "Flexible construction evolution": observed during completion; after completion; soil refixing process ongoing

#### 4.3.2 Current state of reference scenarios (pre-restored scenario and targeted scenario)

A complementary analysis of the reference scenarios (see protocol 3 and construction site analysis report template) must also be accomplished in order to assess the overall beneficial effects of the bioengineering intervention:

- Erosion processes observed: YES/NO
- Slope instabilities observed: YES/NO

- Vegetation properties (trees, shrubs, heights, diameters, land cover, biodiversity indexes, survival rates, etc.)
- Soil properties
- Etc.

#### 4.3.3 In situ field work variables analysis

The field work variables to analyse can be classified according to their nature:

##### WOODEN ELEMENTS

- Tree species used for the timber utilized in the work
- Diameters used
- Mechanical properties measures of both the deteriorated logs and green samples of the same tree species
- Cross sectional loss: comparison between the initial and current diameter values
- Deterioration of the wooden elements near the nails (pilot holes are zones with higher vulnerability risk to the pathogen actions)
- Etc.

##### PLANTS (IN/OUT THE BIOENGINEERING WORK)

- Plant species (tree, shrub and herbaceous)
- Heights and diameters
- Land cover rate
- Biodiversity index (n° of species)
- Evolution of plant composition: number and quantity of the different species.
- Invasive allochthones plants affecting the area
- Root depth
- Root spread
- Root tensile strength
- Root pull out strength
- Etc.

##### SOILS

- Soil moisture
- Soil pore pressure
- Organic matter content
- Aggregate stability
- Shear strength
- Etc.

##### WATER/TEMPERATURE/CLIMATE

- Precipitation amount evolution
- Insolation amount evolution
- Snow period evolution
- Temperature (air/soil)
- Ground water appearance interacting or not
- Air moisture content/humidity
- Drainage (runoff, drains, etc.)
- Storm water management( in Mediterranean climate the success can be related to storm water management)

**OTHER UTILISED GREY AND GREEN MATERIALS**

- Geotextiles biodegradable
- Geosynthetics (e.g., geogrids)
- Rocks
- Steel rods, wire, etc.
- Etc.

*Please note this: All the field work variables will be measured according to the protocol 3 (field work protocol).*

## 5. ANALYSIS OF THE WORK PERFORMANCE

The In this section we should be able to do the following:

- Analysis of the gap between the planned (designed) work and the 'as built' work
- Comparisons between needs for design and construction vs. level of assumptions and stability
- Work performance and beneficial effect analysis

Particularly, the assessment of the bioengineering work elements performance (inert elements, plants, other materials) will be done. Examples of this are the following:

- Suitability of the plant species utilized in the work: Are the plant species well adapted to the site conditions (soil, climate, aspect, etc.)?
- Were the seeds used for the hydroseeding appropriately selected?
- Problems related to the lack or abundance of water
- Problems related to an excessive plant density
- Problems related to soil fertility
- Problems related to slope aspect/angle/topography
- Problems with availability and adequacy of workforce with relevant qualifications
- Problems with access to site
- Problems with health/safety (e.g. invasive species)
- ... related to a maintenance contract failure
- ... related to a missing maintenance contract
- Etc.

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ECOMED is an ERASMUS+ co-founded programme promoted by Universidad Politecnica Madrid which aims to improve the specialisation level of the ecoengineering sector in Mediterranean areas and within this context, this project offers to provide a sound and practical knowledge based on the accumulated experience in order to offer to the next generation of practitioners and managers a solid and well suited training in ecoengineering restoration techniques in Mediterranean scenarios.

**For further information**

[www.ecomedbio.eu](http://www.ecomedbio.eu)