WORK PACKAGES

The work plan and the work packages (WP) for the organization of the project can be summarized in next paragraphs.

Basically, all partners will participate in all WPs and tasks. The degree of participation was explained above in the table "Estimated person months per work package", located in chapter 4 "Administrative details". It is not necessary a flow chart, because the links between the different tasks are so obvious.

WP 1: Project coordination

Scheduled time: months 1-24. This WP is explained in detail below in the section "*Description of Project Management*".

WP 2: Generating scenarios

Scheduled time: months 1-8. Comparison of scenarios is one of the major tools that can help the decision makers. In this stage, the aim is both to describe the current status and to generate different scenarios (i.e. different "pictures" of future development). These scenarios will serve as an input to the riparian vegetation model, representing both the nowadays situation and possible future conditions for natural and affected rivers. This WP comprises the following tasks:

T2.1- Review and description of the most relevant impacts

Review description of the most relevant impacts (i.e. canalisation, dam operation, land use, irrigation, ...) in the European rivers and more specific in the countries of the three partners.

T2.2- Gathering climate information and climate change scenarios

Defining representative climate change scenarios for the regions where the study sites will be located, in the three countries.

T2.3- Making a pre-selection of natural and altered study sites

In the selection will be considered sites with different expectations about potential climate change impacts (for WP4); in the pre-selection of altered study sites (with regulated flow regime) we will consider different dam operation schemes (for WP6). The partners consider a priority to include sites with permanent and also non-permanent flow regimes (relevant in the Mediterranean context).

T2.4- Selection of natural sites for the biological data survey

This selection will be based on the pre-selection (T2.3) eco-region, river ecotypes and water bodies classified for the implementation of the WFD in each river basin. We will select sites in natural or nearly undisturbed conditions. Indexes of ecological status developed in each country will be considered, as well as the reference sites and hydrological reserves included in ecological studies and listed by the water administration in the WFD implementation documents.

T2.5- Selection of case studies with altered flow regime

They will have different dam operation schemes or water management objectives, in the 3 countries. It will be based on WP2 and the data quality in the sites available.

T2.6- Hydrological flow regime

The flow regime will be analysed based on data from flow gauging stations. If they do not exist, the hydrologic distributed model TETIS (Francés & Velez, 2004; Francés *et al*., 2007) will be used to simulate river flow data. A special attention will be paid to the recurrence period and the hydraulic conditions associated with the floods, therefore flood risk maps and associated studies will be an important input in the study (i.e., Francés *et al.,* 2001).

In any case, the hydrological modelling will be needed in order to asses properly the different flow regime scenarios due to hydrological changes, human intervention and/or climate change.

WP 3: Development of RIPFLOW model

Scheduled time: months 4-14. This WP is the core of this project. It comprises the following tasks:

T3.1- Definition of the main questions for water management

In cooperation with the end-users panel (mainly water managers) we will define the *main questions* to be answered in order to make decisions of water management and assessments of environmental flow regimes. The model RIPFLOW will allow the simulation of different climate scenarios and the relevant dam operation schemes (defined in WP2), and their effects on the riparian forest. RIPFLOW will consider the role of minimum flows and also floods in the maintenance of channel morphology and riparian forest recruitment.

T3.2- Definition of RIPFLOW information flow

The outputs (data files in different formats, tables, charts, etc.) must be defined for a friendly and clear presentation of results for the water managers (flow characteristics, vegetation types, critical values, thresholds, etc.) in a friendly interface. A relevant part of the outputs will be an assessment of the ecological status, based on the riparian vegetation.

It is also crucial to select the data format for inputs, as well as importing capabilities to receive information of dam operation schemes, climate change scenarios and also the outputs from another tools of water management, if there are any in the water administrations of the end-users.

This definition of information flow must be conditioned to the economical optimization of field work methods. This aspect will be important to get a reliable sub-model and answer the *main questions* at an affordable cost (coherent with our budget).

T3.3- Definition of the model conceptualization and structure

The riparian vegetation sub-model and the whole model RIPFLOW will be dynamic, because it is necessary to consider long-term changes of the driving parameters in the riparian system, as well as the changes in physical conditions, habitats and vegetation succession.

In order to handle the complexities of the system, a vegetation model has to be built by the use of sub-models. The most important components of riverine ecosystem models are: hydraulic and hydrological processes, which drive geomorphologic processes (sedimentation, erosion) and soil moisture (groundwater, soil conditions), feeding back on hydrology. All three act on riparian vegetation (interactions of plants, succession and disruption as well as disturbance of plant communities). Of course, these in turn shape processes in the hydrological and the geomorphologic system component, e.g. if vegetation growth changes roughness values that reduce flow velocity, leading to higher sedimentation rates which in turn change soil conditions and hence the soil-specific vegetation.

The partners have discussed about the basic structure, from the beginning of this proposal, based on their experience in the application of hydrologic, hydraulic, physical habitat and riparian vegetation models. The basic structure for the dynamic riparian ecosystem model is shown in the attached figure. In this task the following described concept for the model will be revised and definitely defined. The most important model input parameters are discharge, bed load and climatic data. Important model variables are topography, roughness, shear stress, soil moisture and growth velocity.

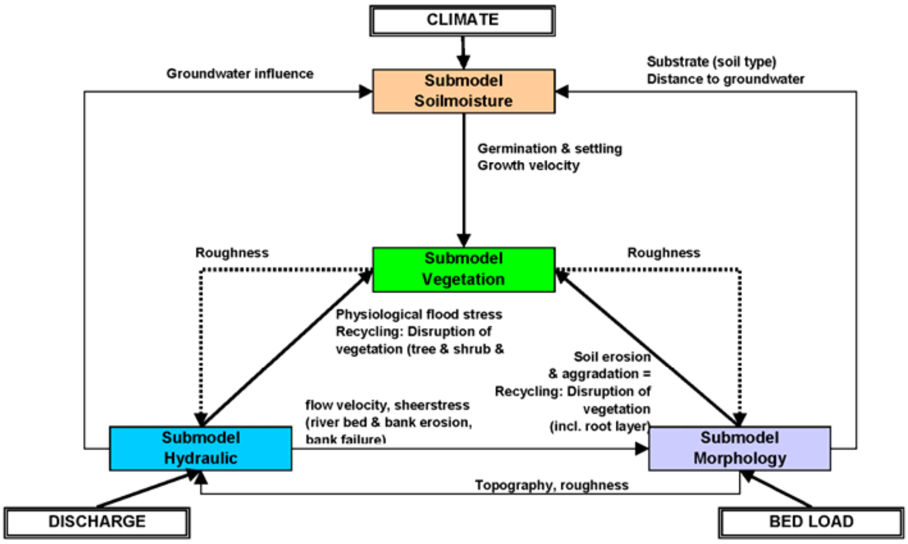

Figure 1. Possible input data, parameter and variables of a riparian ecosystem model.

T3.4- Programming of the model

In the programming, the main work consists of physical and ecological processes. It is necessary the development of the hydraulic, morphology and soil sub-models, which outputs are necessary inputs in the vegetation sub-model. The final outputs of RIPFLOW will be both analytical and graphical results.

A part of the graphical results will be obtained in analyses developed in ArcGis 9.2®. (ArcMap model builder, application using Python and ArcScene for 3D visualization). The linkage between sub-models (soil, hydraulic, morphology and vegetation in ArcGis 9.2) will work automatically, and the whole model will be based on monthly or yearly step iterations.

For each model iteration is generated a vegetation cover map (raster format). In order to make the model's output meaningful for non experts, a visualization module was implemented to convert the raster maps to 2D (polygon) or 3D (point) representations. Maps can be then grouped to produce a 3D animation which displays the evolution of the system over the simulated years. Using the discharge data for each year, it was also possible to build an animated chart of the landscape along the years of study. Maps outputs were also used to perform spatial analyses and give summary data for decision support. An example obtained from previous models is shown in next figure.

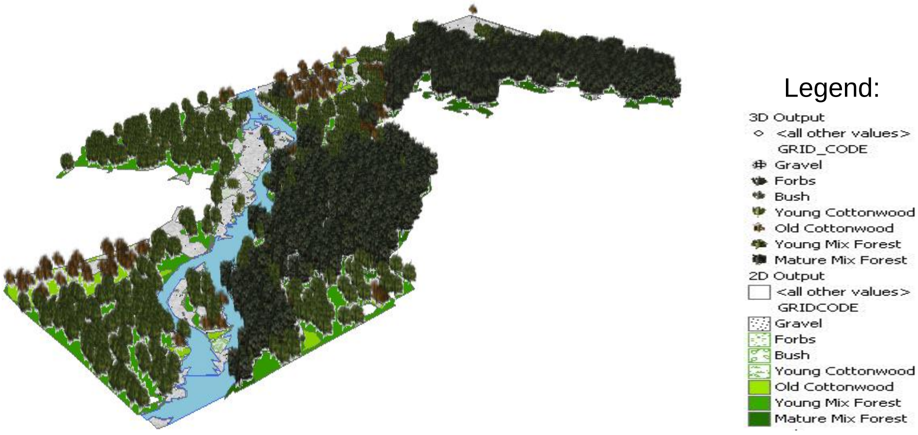

Figure 2. 3D Output combined (point & polygons) from a riparian vegetation study, in ArcGIS 9.2®.

WP 4: Field data acquisition and processing

Scheduled time: months 8-14. The partners have experience in the methods and different tools applied in vegetation surveys, and have demonstrated their ability to evaluate the most cost-effective techniques, in order to reach the project goals. This WP comprises the following tasks:

T4.1- Hydraulic and biological survey in natural river sites

In order to obtain hydraulic models in each natural site, hydrometry surveys will take place in a segment of each site, and also the topography to have explicit data of the spatial distribution of the riparian plants. Basically, two types of surveys will be done:

1. Hydrometry for hydraulic & habitat modelling (1Dim)

In each study site a number of transects will be located in order to make the surveys of hydrometry, habitats and vegetation patches. Transects must be selected to represent the hydraulic and habitat diversity, as well as the longitudinal profile of the water surface along the study site. Surveys will be done with 2 or 3 different flow rates during the hydrologic year, so that we can calculate rating curves afterwards (water elevation-flow rate).

2. Characterizing habitat patches & vegetation

In each of the natural study sites we will make a survey with the “line intercept method” (Firemon, 2003), along the transects mentioned before. In the transects will be identified and geo-referenced the most representative habitat patches and the vegetation present (trees, shrubs, forbs and herbs). There will be a core sampling in the trees and shrubs in order to get the age and calculate growth curves. The soil will be also sampled, in order to estimate the development of the soil, frequency of flow disturbances and depth of productive soil.

T4.2- Biological data processing in natural rivers

The biological data will be analyzed on order to get the parameters and information necessary for the model calibration and validation in natural sites. From the hydrometry data, we will obtain the rating curves (water elevation-flow rate) in each transect, with the software RHYHABSIM (Jowett, 1989). The flow time series will be transformed into water elevation time series and the statistical analyses will be based on these data. Based on the series, we will analyze the relationships between each succession stage (in a certain habitat type) and the hydrological characteristics of the river reach. Habitat conditions will be characterized in terms of flood frequency, erosion/sedimentation processes and elevation above water table.

Vegetation will be characterized in terms of elevation above water level and above river thalweg, mean and maximum age of trees, height, diameter (at the base and breast height), mean estimated density and coverage.

From the data obtained in the field, it will be calculated the percentage of presence for the riparian vegetation species, the representative succession series and the habitat conditions where each stage (face) of the succession occurs. In this stage of the analyses, the main statistical tool will be the canonical correspondence analysis. From the age data (trees and shrubs) will be calculated the growth curves (age-diameter, age-diameter-height relationships) and the estimated number of years that each succession face can last approximately in a region. This is essential information for the dynamic riparian vegetation sub-model within RIPFLOW.

T4.3- Hydraulic and biological survey in altered river sites

In order to create and calibrate the hydraulic sub-model in the case studies with altered flow regime, hydrometry surveys will take place in a segment of each site. The vegetation survey in these cases will be design to balance the necessary accuracy for the model, the economy and the easy application of the methods, in order to make it easy to apply in any other European river. The representative habitats (defined in the data processing of natural sites) and the species present will be recorded, in order to define the “present condition” and to validate the model.

WP 5: Model application to case studies

Scheduled time: months 15-24. This WP comprises the following tasks:

T5.1- Calibration and validation of the model

It will be necessary to calibrate and validate the model in ecologically different river ecotypes and ecoregions, in order to cover a wide range of riparian ecological conditions in Europe, with permanent and non-permanent flow regime. The case studies will be located in Austria, Spain and Portugal.

T5.2- Model simulations in the case studies

In the selected cases of the 3 countries, we will simulate the long term effects on the riparian vegetation of different scenarios (i.e. dam operation rules, change of land use, recruitment of the riparian vegetation in Natura 2000 areas) combined with climate change scenarios.

T5.3- Proposal of general water management recommendations

The analysis of the previous results must produce a proposal of general water management recommendations and site-specific environmental flow regimes considerations. This water management proposal will be dedicated to the achievement and conservation of a good ecological status in the native riparian forest, under the simulated scenarios.

The partners can give some examples about the kind of results that will be obtained from the RIPFLOW simulations (site-specific), based on their previous experience in environmental flows and vegetation studies:

i) Recommended rules for water management in order to improve the ecological status/reach the good status level in *Natura 2000* sites.
ii) The model will be able to predict riparian vegetation structure in non-disturbed situations, a necessary step for benchmarking restoration *sensu* WFD.
iii) Expected changes of the ecological status (based on riparian vegetation) under different climate change scenarios, in the long term.
iv) Recommended environmental flows, including flow magnitude and recurrence, for the maintenance of the native riparian species.
v) Recommended water management rules that could minimize or mitigate the future impact of the climate change on the ecological status, under different climate change scenarios.

T5.4 Feedbacks to the RIPFLOW model

Based on the final results, discussion and feedback from the end-users.