VEgetation NUtrient-retention Service (VENUS) index: an indicator to assess favourable conditions for nutrient retention by vegetation

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online discussion forum

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Objectives

- To provide a reliable distribution map of suitable conditions for the occurrence and potential intensity of nutrient regulation ecosystem service
- To provide indications for riparian vegetation management interventions
- To increase the efficacy of riparian management plans with regard ecosystem services provision, particularly for nutrient regulation

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Ecosystem services

- **Natural capital** is the world's stock of natural resources, which includes geology, soils, air, water and all living organisms.

- **Ecosystem functions** are natural process or characteristic exchanges of energy that take place in the various animal and plant communities of the different biomes of the world.

- **Ecosystem services** are ecosystem functions that provide benefits for people.

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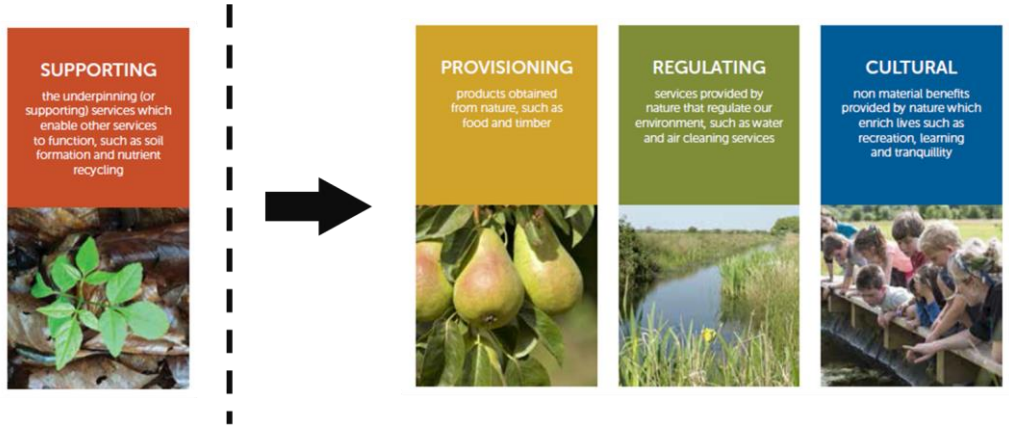
Ecosystem services



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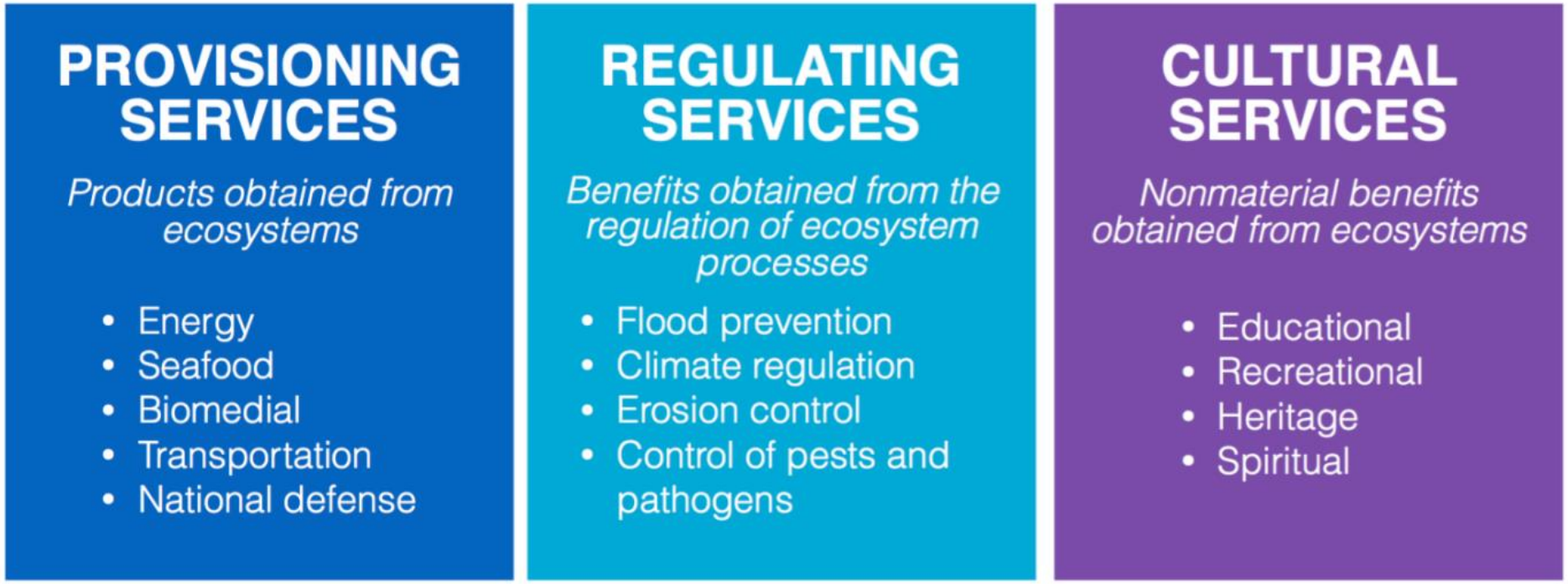
Ecosystem services



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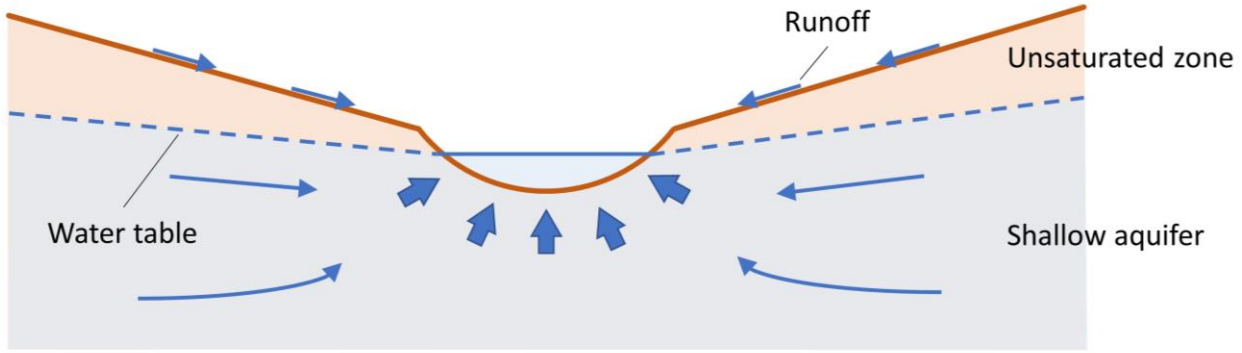
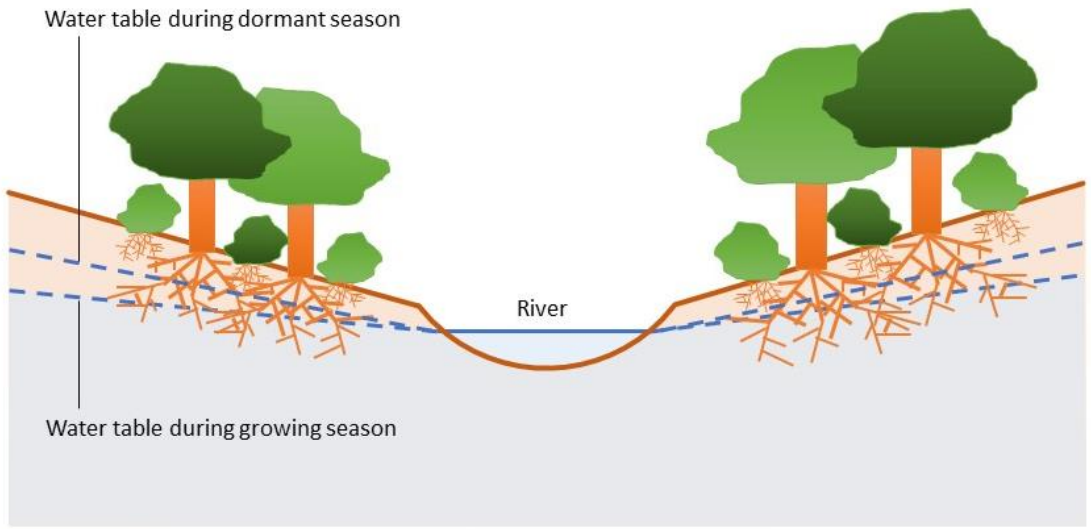
Nutrient Retention by Riparian Vegetation





Nutrient regulation in Riparian Buffer Zones (RBF) results from the combination of different processes: denitrification, sorption, precipitation, uptake by vegetation roots and immobilisation by microorganisms.

Occurrence strongly controlled by interactions between water and roots system.

Specific environmental conditions contribute to nutrient retention, as nutrients reach superficial water mainly following two major paths: runoff and groundwater baseflow

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Main controlling factors

Water table depth (WT): groundwater transfers nutrients towards rivers. Where water table is close to the surface, vegetation nutrient uptake is favoured, as interactions between water and root system can take place. Also, persistent shallow water table determines reduction conditions, that in turn favour denitrification processes.

Vegetation cover (V): nutrient uptake by vegetation depends on root systems and the organic matter stored into soil. Deep and dense root systems favour nutrient uptake from groundwater, as they have potentially large root hair zone, resulting in high total surface for nutrient uptake. Organic matter from vegetation cover is stored in soils and enhances biological activity, which in turn contributes to nutrient consumption.

Soil texture (ST): texture controls soils permeability and affects flow velocity, hence contact time between roots and water. In low-permeability soils (clay and silt) contact time is higher than in high-permeability soils (gravel and sand), but high percentage of cohesive materials counter root system development. Generally, loam soils present the ideal conditions in terms of permeability (medium to low) and for root system growth (and root hair zone).

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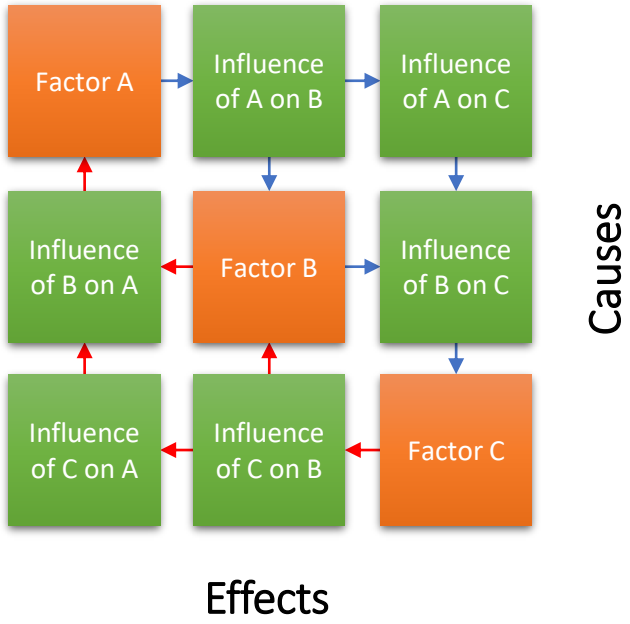
Combining the main factors

Binary interaction matrix (BIM) (Hudson, 2013)



Interactions between the factors

- 0 no interaction
- ±1 weak interaction
- ±2 medium interaction
- ±3 strong interaction
- ±4 "critical" interaction

Factor weight (k_i) = $(C_i+E_i) / (\Sigma C + \Sigma E)$

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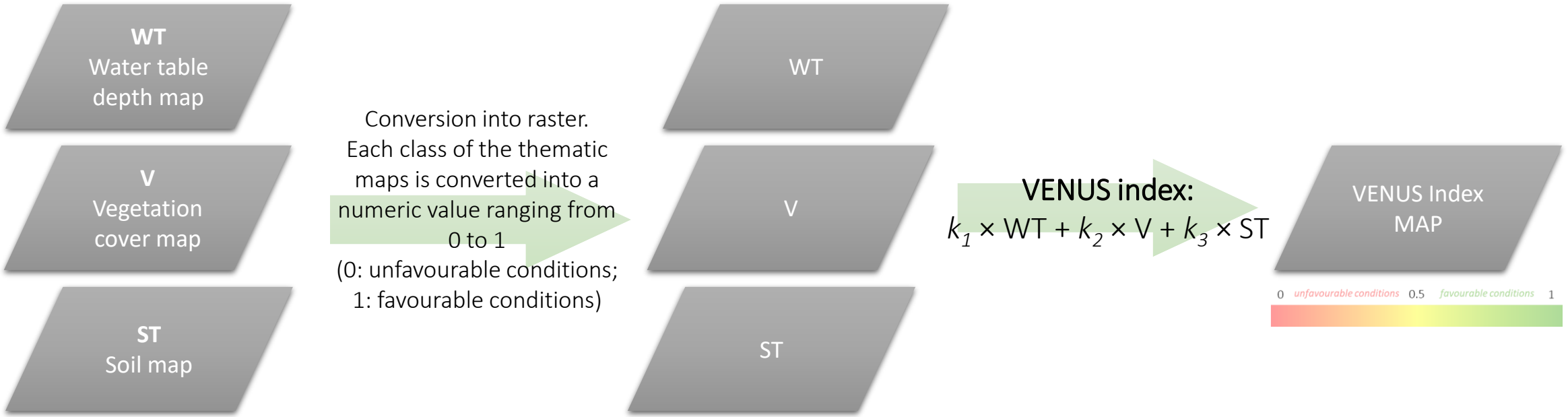
Processing the main factors

GIS processing



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Study area

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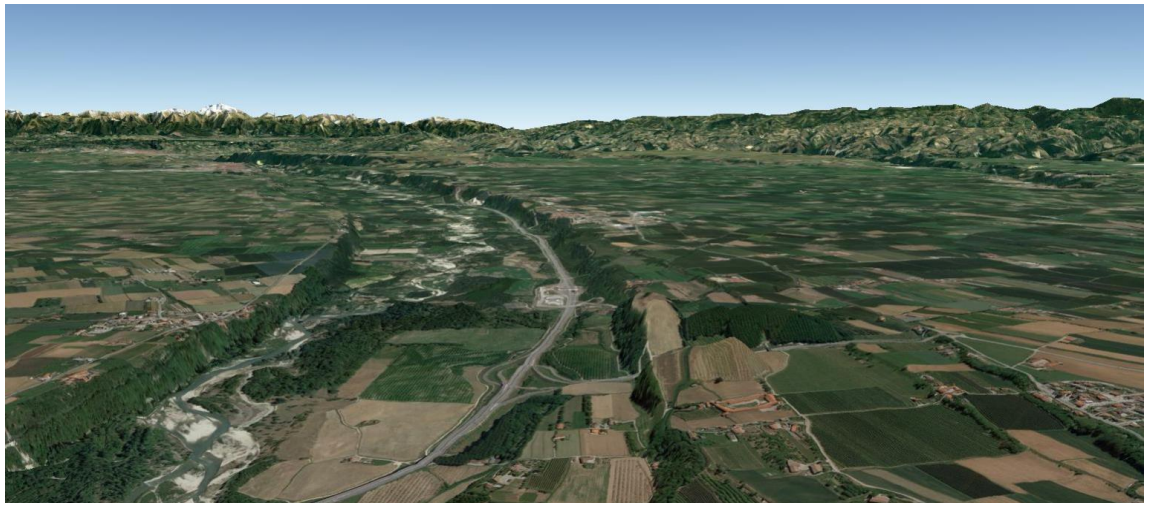
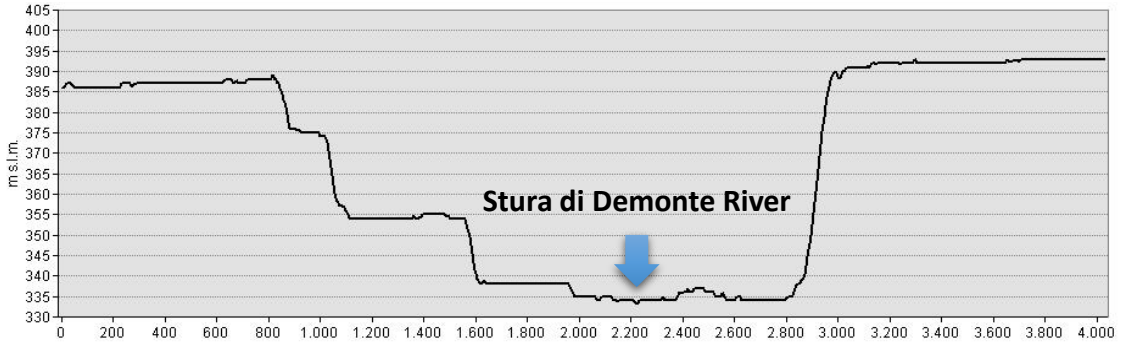
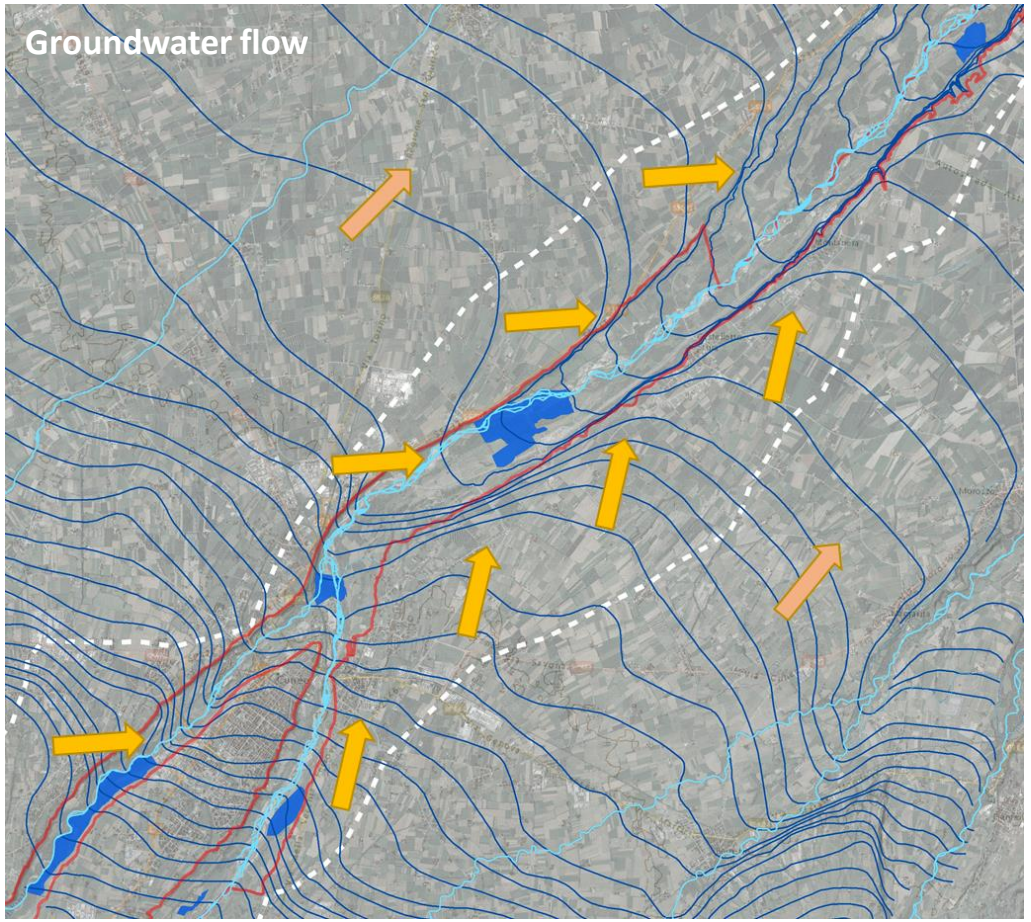
Study area



Study area corss section





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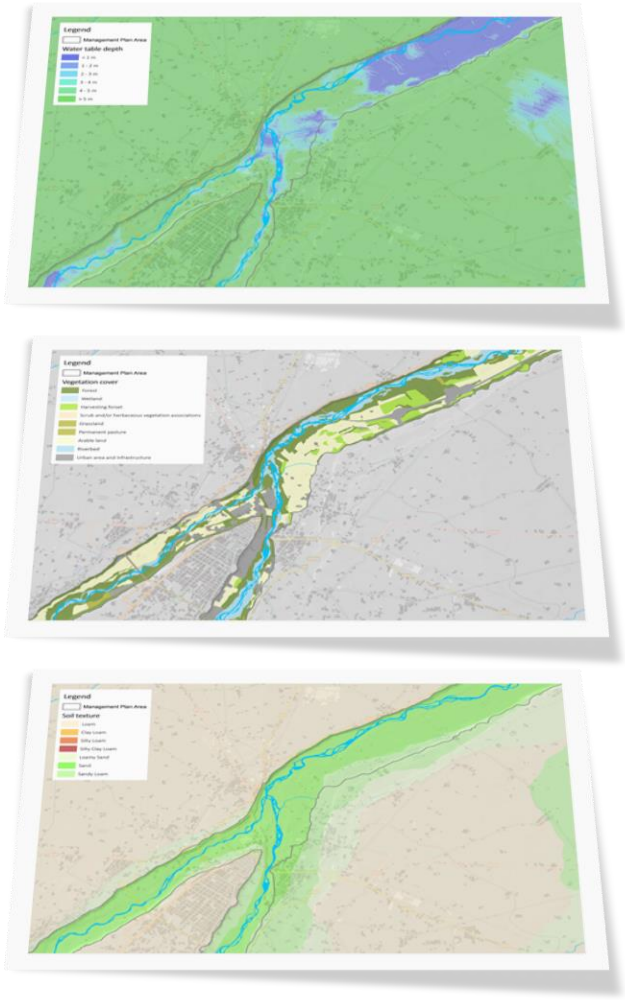
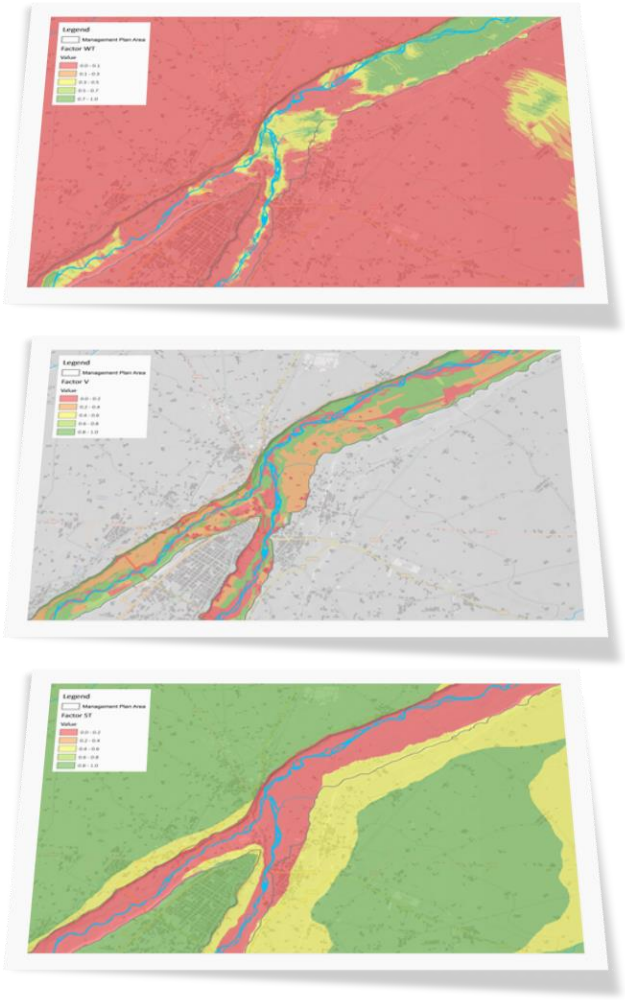
Results

Input maps

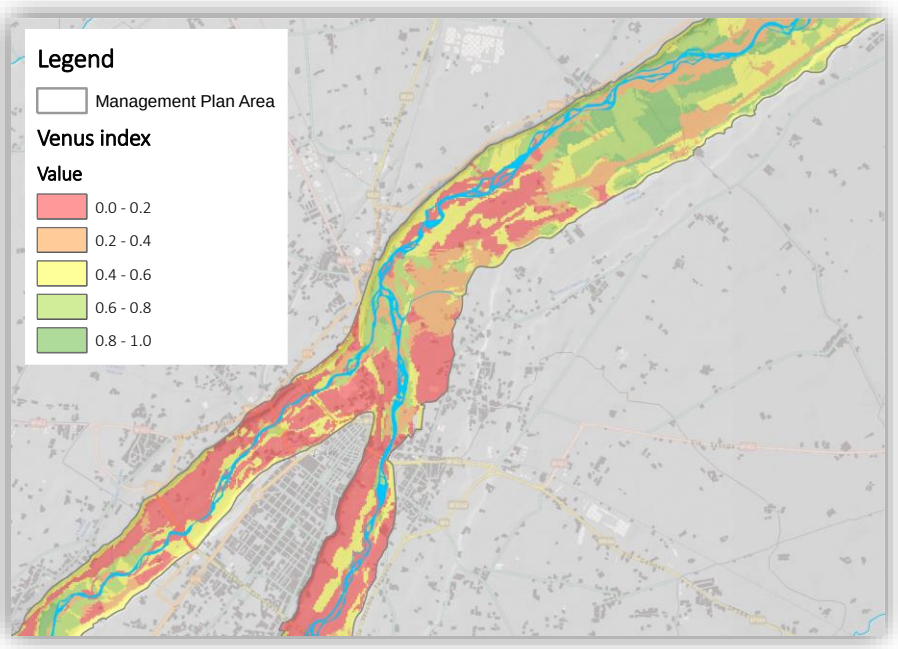


Raster maps



VENUS Index map

0 *unfavourable conditions* 0.5 *favourable conditions* 1



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Conclusions

The application of the VENUS Index improved the definition of management measures for riparian vegetation and allowed reaching the following results:

(1) identification of Riparian Buffer Zones (RBZ) homogeneous sectors in terms of relevance for nutrient retention ecosystem service, from data normally acquired for the definition of a Riparian Vegetation Management Plan;

(2) assessment of different RBZ management scenarios regarding nutrient retention performance;

(3) definition of specific management measures to preserve and/or foster the provision of the ecosystem service nutrient retention.

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