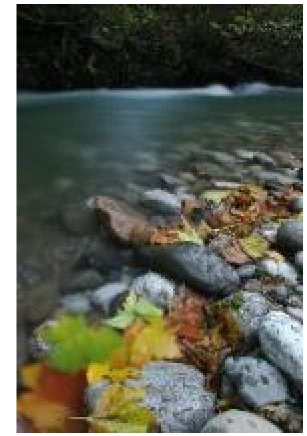
Myths about forest and water: The need for evidence-based knowledge for the design of Green Infrastructure Networks

GS04: How ecology serves the society: services and nature-based solutions

1st Meeting of the Iberian Ecological Society & XIV AEET Meeting.

Ecology: an integrative science in the Anthropocene

José Barquín*, José M. Álvarez-Martínez, Ignacio Pérez

Environmental Hydraulics Institute, Universidad de Cantabria, Avda. Los Castros s/n, 39005 Santander, Cantabria, Spain

*barquinj@unican.es

ALICE

Interreg Atlantic Area

European Regional Development Fund

EUROPEAN UNION

The ALICE project

Blue-Green Infrastructure Network (BGIN) refers to all natural and semi-natural landscape elements that can form a green-blue network. These infrastructures are designed and managed to deliver a wide range of ecosystem services. Restoration of coastline forests, retention of nutrients (to improve water quality), habitat improvement for target species are some of the multiple functions provided by blue and green infrastructures.

Ecosystem Services (ES) are the benefits that humans obtain from natural environment and from properly-functioning ecosystems, such as clean air, purified water and food provision.

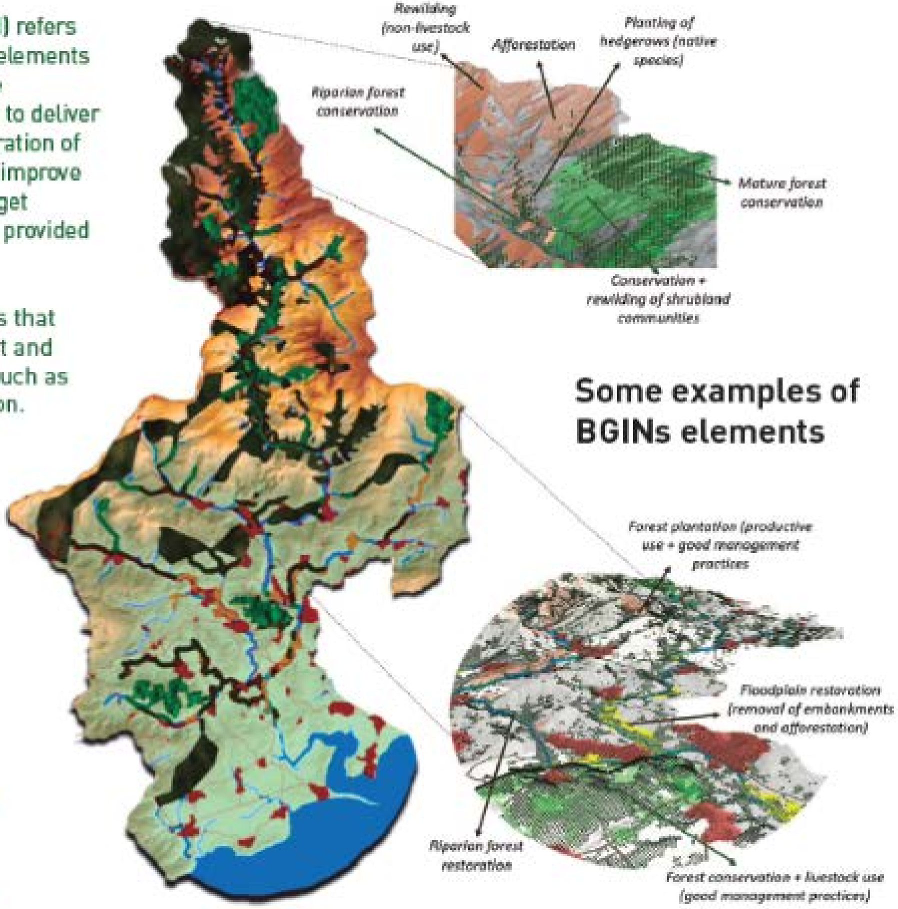
BGIN elements

To be conserved
Hillside ecosystems
Riparian and other lineal habitats

To be restored
Hillside areas
Foodplains
Riparian areas

Water bodies
Water courses

Population centre
Road



http://project-alice.com/

The ALICE project

Blue-Green Infrastructure Network principles:

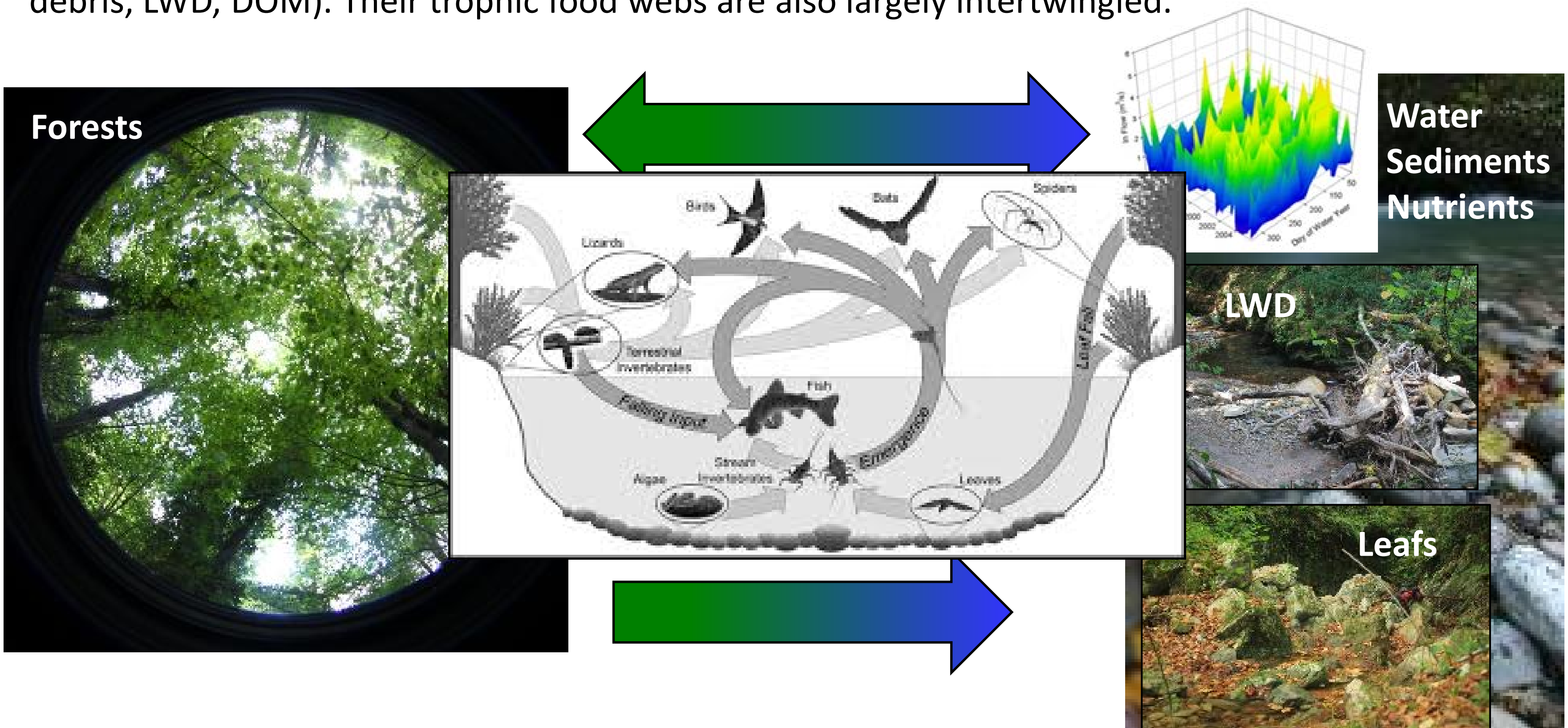
1. Connectivity is critical.
2. Context matters.
3. GIN should be designed before developed
4. GIN design should be grounded in evidence-base science.
5. GIN design must incorporate participative approaches.
6. GIN should function as the framework for conservation and development.
7. GIN design and implementation requires investment.
8. GINs require long-term commitment.

Adapted from ***Benedict & McMahon, 2006***

Rivers and Forests…

Differences: Rivers are dendritic and open ecosystems with an important role of stochastic processes (e.g. flood disturbances), while forest are more closed ecosystems in which deterministic processes dominate (competition).

Dependencies: Both ecosystems interchange water, nutrients, sediments and C-sources (e.g. Leafy debris, LWD, DOM). Their trophic food webs are also largely intertwingled.



Rivers and Terrestrial ecosystems: The role of forests

Received: 26 May 2017 | Accepted: 2 October 2017
DOI: 10.1111/2041-210X.12925

RESEARCH ARTICLE

Methods in Ecology and Evolution

Modelling the area of occupancy of habitat types with remote sensing

Jose Manuel Álvarez-Martínez[1] | Borja Jiménez-Alfaro[2,3] | José Barquín[1] | Bárbara Ondiviela[1] | María Recio[1] | Ana Silió-Calzada[1] | Jose Antonio Juanes[1]

Correspondence
Handling Editor

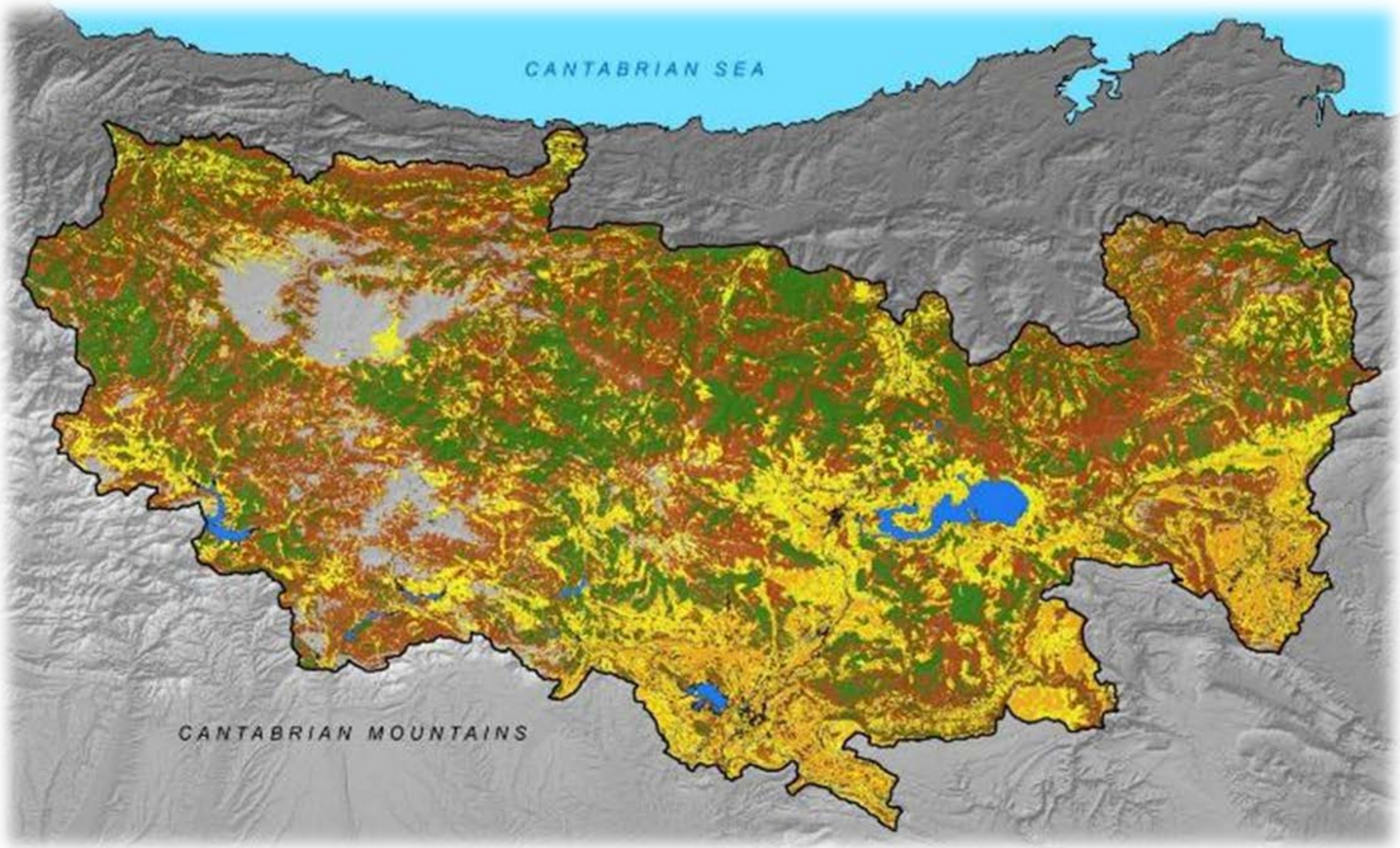
Abstract

1. A current challenge of biodiversity and conservation is the estimation of the spatial extent of habitat types across broad territories. In the absence of fine-resolution maps, predictive modelling helps in assessing the spatial distribution of vegetation cover. However, such approaches are still uncommon in regional planning and management. Here, we present a framework for mapping the area of occupancy (AOO) of habitat types that allows highly suitable estimates at different scales.
2. We model the potential AOO with abiotic variables related to topography and climate, resulting in broad AOO estimates that are subsequently downscaled to the local AOO with remote sensing. The combination of individual local AOO estimates allows the defining of the realized AOO, comprising locations with a high suitability and low uncertainty for each habitat. We applied this framework to mapping 24 protected habitat types of Natura 2000 sites in northern Spain.
3. Local and realized AOO were highly accurate, with a 70% overall accuracy for the realized AOO. Remote sensing data, and especially LiDAR, were the most important predictors in habitat types related to forests and shrubs, followed by rock outcrops and pastures. Environmental variables were also relevant for specific habitats subject to abiotic constraints.
4. The combination of ecological modelling with remote sensing offers multiple advantages over traditional field surveys and image interpretation, allowing the harmonization of habitat maps across large regions and through time. This is particularly useful for implementing conservation actions under Natura 2000 principles or assessing IUCN criteria for ecosystems.

KEYWORDS
biodiversity, Cantabrian Mountains, conservation status, Natura 2000, predictive modelling

1 | INTRODUCTION

There is increasing interest in the mapping of the distribution of ecosystems as an effective tool for conservation planning for natural areas (Margules & Pressey, 2000; Pressey, Cabeza, Watts, Cowling, & Wilson, 2007). To establish the International Union for Conservation of Nature (IUCN) Red list of Ecosystems, Rodríguez et al. (2013) defined the extent of occurrence (EOO) and the area of occupancy (AOO) to characterize spatial distributions. EOO is the "area contained within the smallest polygon encompassing all the known, inferred or projected sites of present occurrence of an ecosystem," while AOO is the "area within EOO actually occupied by an ecosystem." These concepts are analogous to those used in species distribution modelling as they represent the reduction from potential to occupied distributional



- Broadleaf orests
- Conifer afforestations
- Shrublands
- Agriculture land
- Pasture and hedged meadows
- Rock outcrops
- Urban and bare land
- Water

Classification of land cover using a Landsat image from 2010
(see Álvarez-Martínez et al., 2017)

ALICE
Interreg Atlantic Area
European Regional Development Fund
EUROPEAN UNION

IH cantabria
INSTITUTO DE HIDRÁULICA AMBIENTAL

Forest & Water

Rivers and Terrestrial ecosystems: The role of forests

Received: 26 May 2017 | Accepted: 2 October 2017
DOI: 10.1111/2041-210X.12925

RESEARCH ARTICLE

Methods in Ecology and Evolution

Modelling the area of occupancy of habitat types with remote sensing

Jose Manuel Álvarez-Martínez[1] | Borja Jiménez-Alfaro[2,3] | José Barquín[1] | Bárbara Ondiviela[1] | María Recio[1] | Ana Silió-Calzada[1] | Jose Antonio Juanes[1]

[1]Environmental Hydraulics Institute IH Cantabria, Parque Científico y Tecnológico de Cantabria, Santander, Spain
[2]German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig, Leipzig, Germany
[3]Geobotany and Botanical Garden, Institute of Biology, Martin Luther University Halle Wittenberg, Halle (Saale), Germany

Correspondence
Jose Manuel Álvarez-Martínez

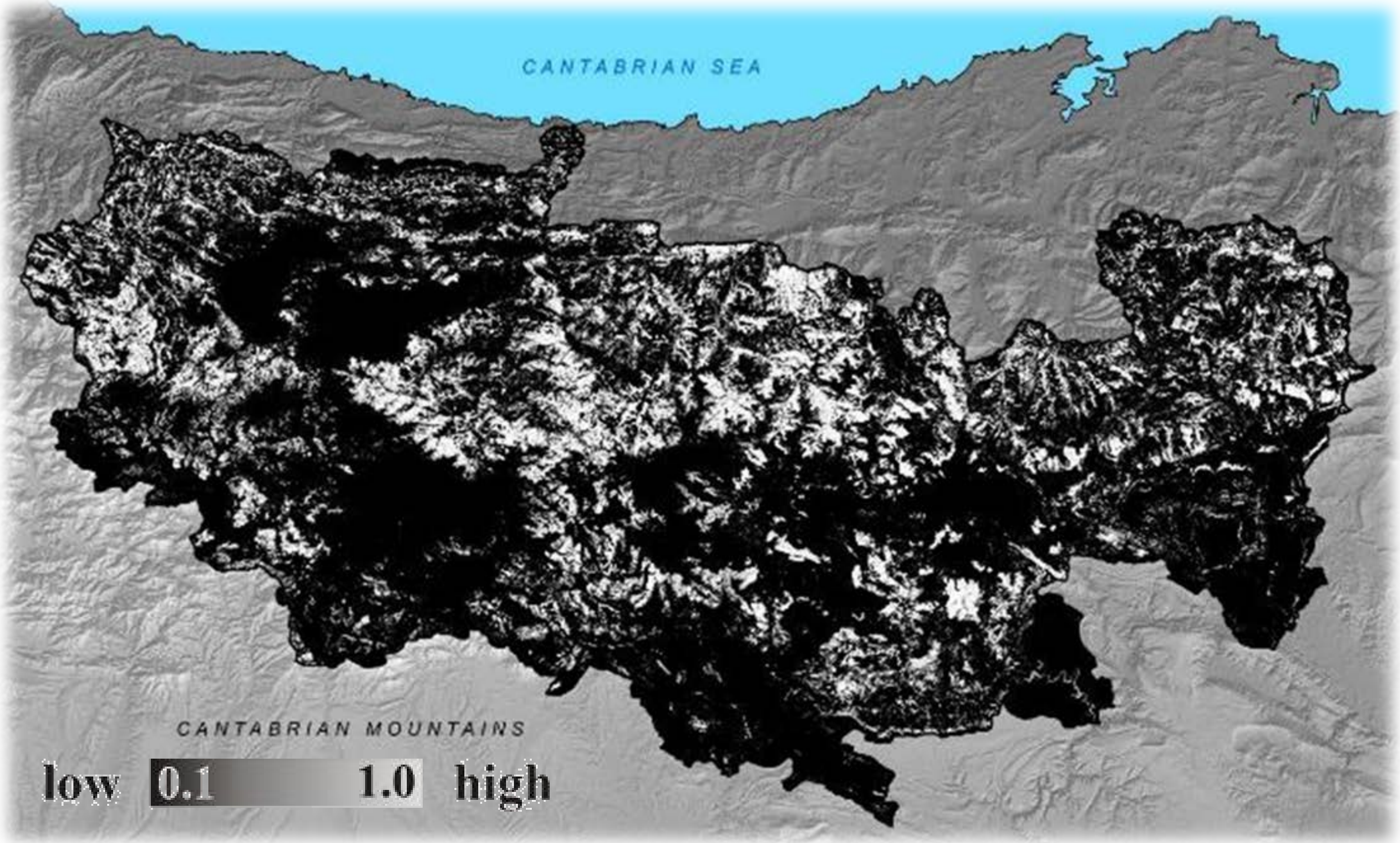
Abstract

1. A current challenge of biodiversity and conservation is the estimation of the spatial extent of habitat types across broad territories. In the absence of fine-resolution maps, predictive modelling helps in assessing the spatial distribution of vegetation cover. However, such approaches are still uncommon in regional planning and management. Here, we present a framework for mapping the area of occupancy (AOO) of habitat types that allows highly suitable estimates at different scales.
2. We model the potential AOO with abiotic variables related to topography and climate, resulting in broad AOO estimates that are subsequently downscaled to the local AOO with remote sensing. The combination of individual local AOO estimates allows the defining of the realized AOO, comprising locations with a high suitability and low uncertainty for each habitat. We applied this framework to mapping 24 protected habitat types of Natura 2000 sites in northern Spain.
3. Local and realized AOO were highly accurate, with a 70% overall accuracy for the realized AOO. Remote sensing data, and especially LiDAR, were the most important predictors in habitat types related to forests and shrubs, followed by rock outcrops and pastures. Environmental variables were also relevant for specific habitats subject to abiotic constraints.
4. The combination of ecological modelling with remote sensing offers multiple advantages over traditional field surveys and image interpretation, allowing the harmonization of habitat maps across large regions and through time. This is particularly useful for implementing conservation actions under Natura 2000 principles or assessing IUCN criteria for ecosystems.

KEYWORDS
biodiversity, Cantabrian Mountains, conservation status, Natura 2000, predictive modelling

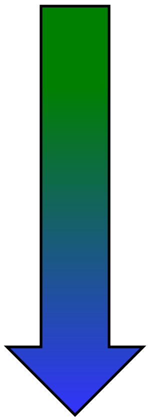
1 | INTRODUCTION

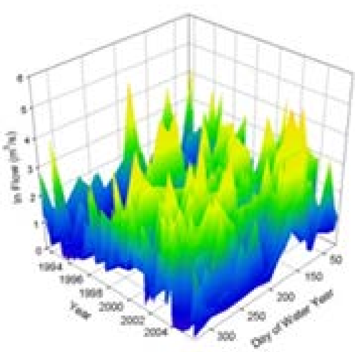
There is increasing interest in the mapping of the distribution of ecosystems as an effective tool for conservation planning for natural areas (Margules & Pressey, 2000; Pressey, Cabeza, Watts, Cowling, & Wilson, 2007). To establish the International Union for Conservation of Nature (IUCN) Red list of Ecosystems, Rodriguez et al. (2015) defined the extent of occurrence (EOO) and the area of occupancy (AOO) to characterize spatial distributions. EOO is the "area contained within the smallest polygon encompassing all the known, inferred or projected sites of present occurrence of an ecosystem," while AOO is the "area within EOO actually occupied by an ecosystem." These concepts are analogous to those used in species distribution modelling as they represent the reduction from potential to occupied distributional



Classification of land cover using a Landsat image from 2010
(see Álvarez-Martínez et al., 2017)

Forest & Water






RESEARCH ARTICLE

WILEY

The role of forest maturity in extreme hydrological events

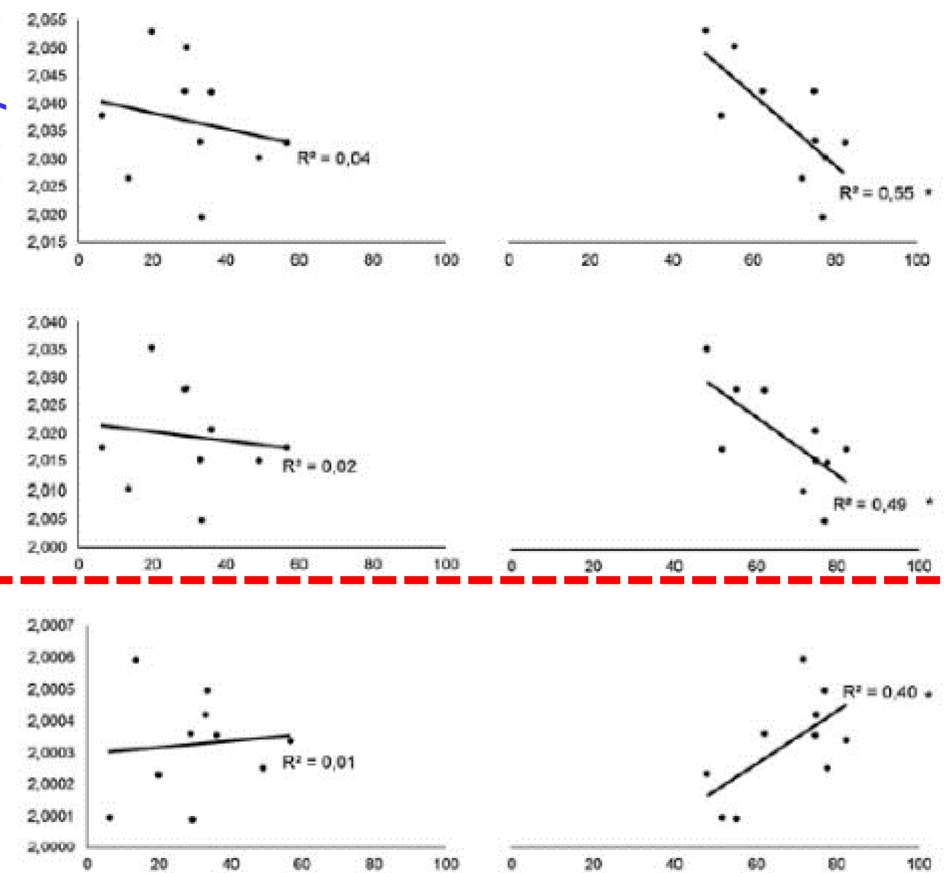
Oscar Belmar | José Barquín | Jose Manuel Álvarez-Martínez | Francisco J. Peñas | Manuel Del Jesus

See Belmar et al., 2018

Intensity of floods

Frequency of floods

Base Flow Index

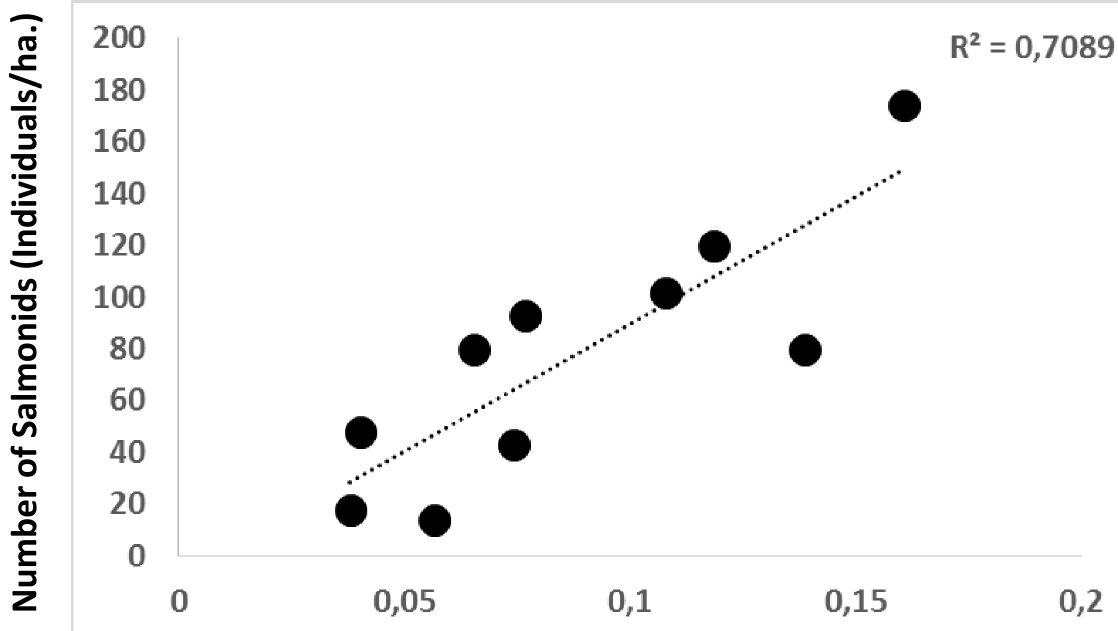


Unexpected ??

Forest cover

Forest Maturity

Forest & Fish

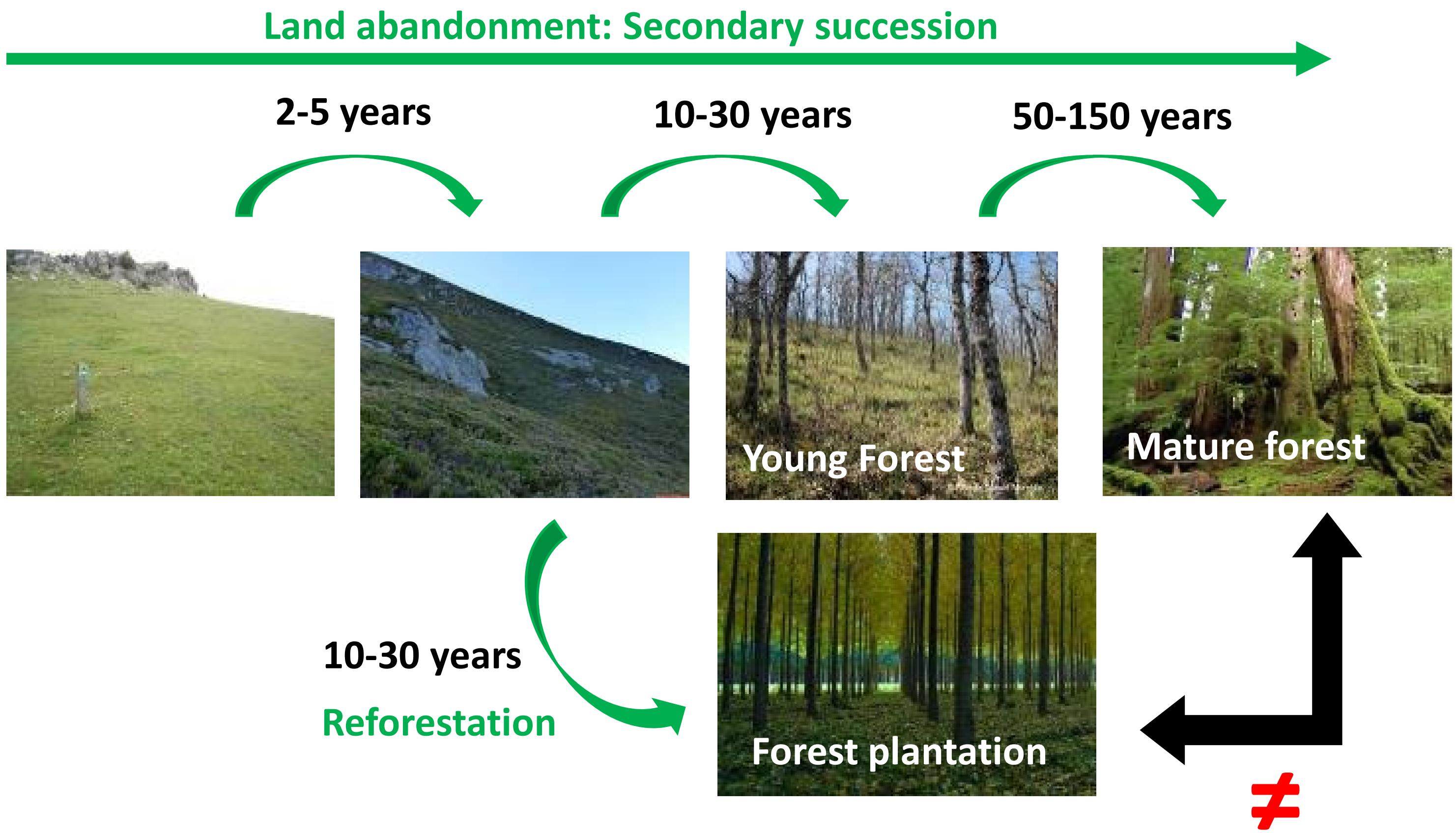


Base Flow Index

Forest Maturity

The role of secondary succession..

Land use intensification produces a lost of mature native forests, while land abandonment opens opportunities for the natural vegetation to recover and mature through **secondary succession**.

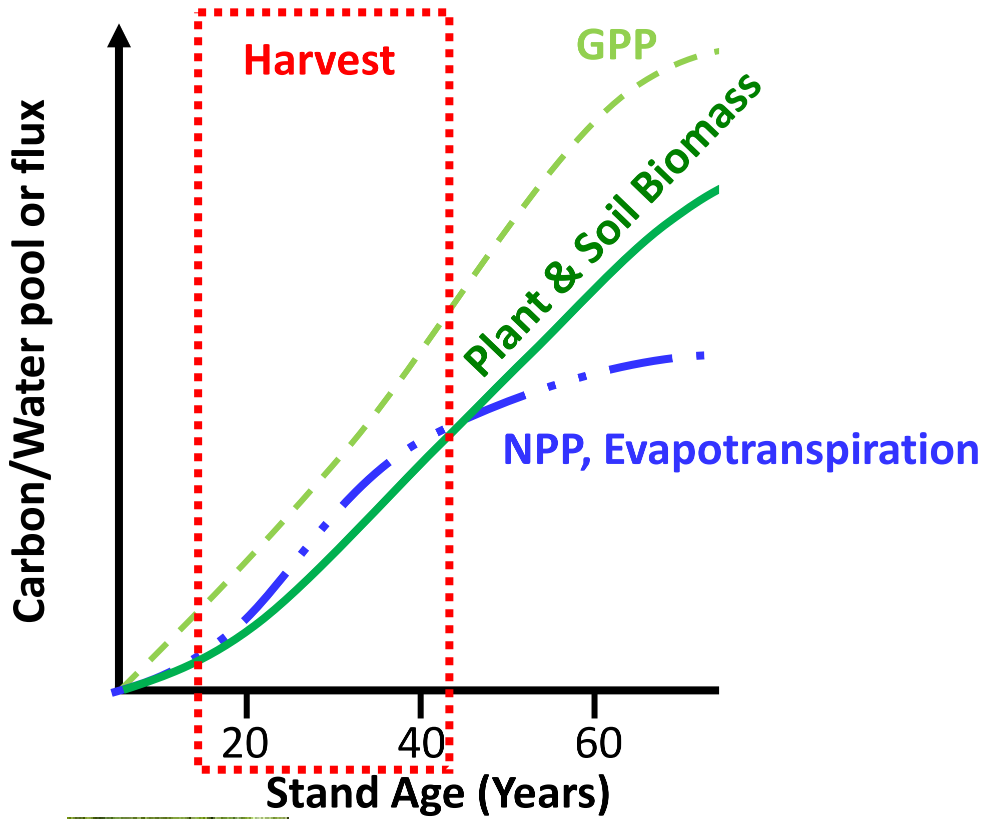


Secondary succession generates properties that differentiate young and mature forests, while traditional forestry practices will not achieve this properties…

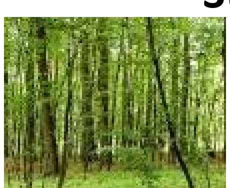
The need for longer timeframes…

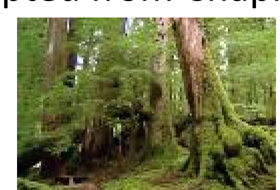
A dangerous message: All forests dry rivers ?? Or is it just young forest and plantations?

There is a strong need to better understand the role of old unmanaged forests (i.e. Mature forests) on hydrological processes versus the role of novel forest or tree plantations…



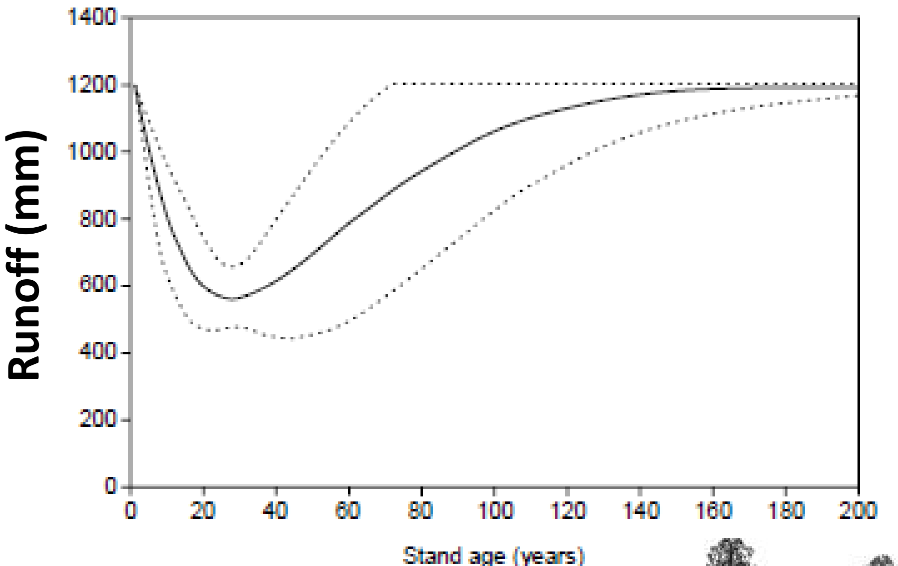
Adapted from Chapin III *et al.*, 2002

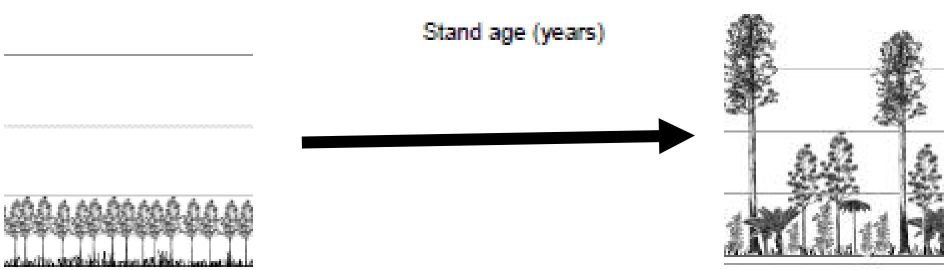




Some evidences from around the globe..

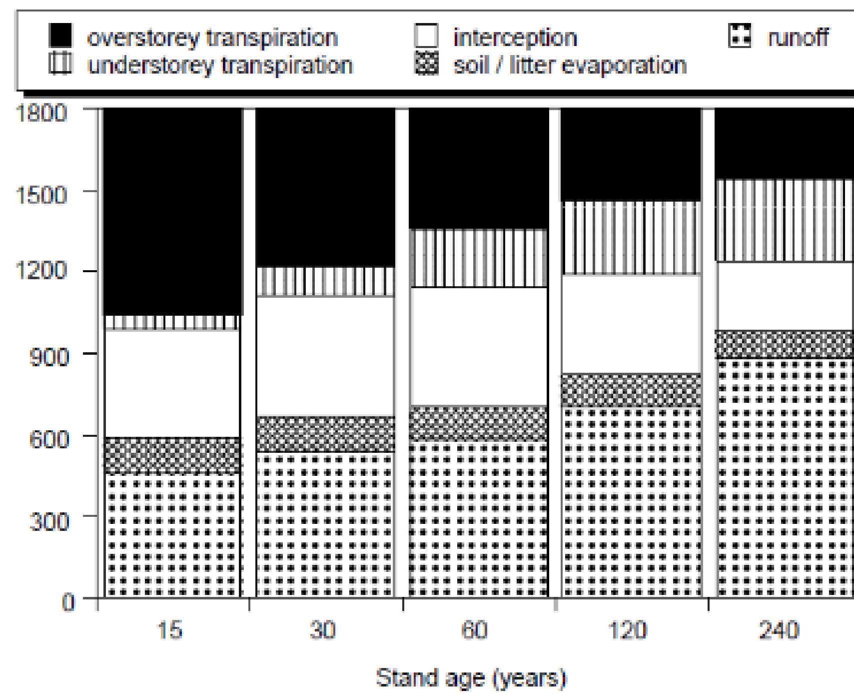
Mountain ash forest (*Eucalyptus regnans*) in Maroondah Reservoir Region, Victoria, Australia, reduce water to streams during the rapid years of growth (up to 40 years), but then recover after forest maturity is reached (>150 years).





The increase in runoff comes from changes in:

- Leaf area index (transpiration, interception)
- Sapwood area (transpiration)
- Reduction of soil evaporation because of accumulation of woody debris and leaf litter..



Vertessy *et al.*, 1998

The need for better differentiation..

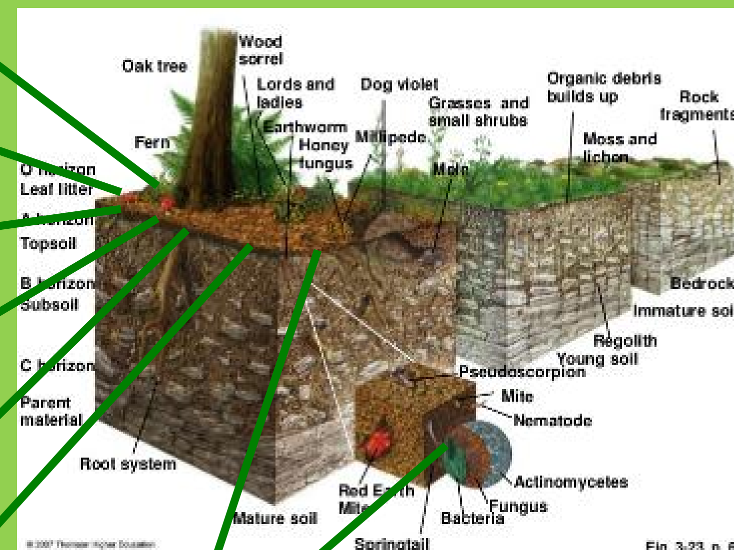
A dangerous message: Do we need to clean forests? Or just tree plantations?

Forest maturation increases the inputs and stocks of large woody debris and leafy debris, increasing the depth of Horizon 0 and many ecosystem functions..

Large Woody Debris

- Erosion control
- Water retention
- OM storage
- Increase Heterogeneity
- Reduced Evaporation
- Increased infiltration
- Temperature Buffered
- Increased Biodiversity

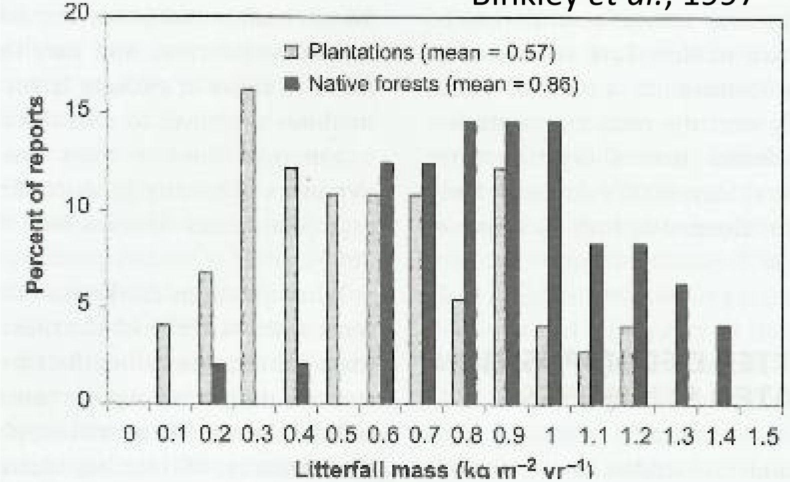
Leaf litter & Horizon 0



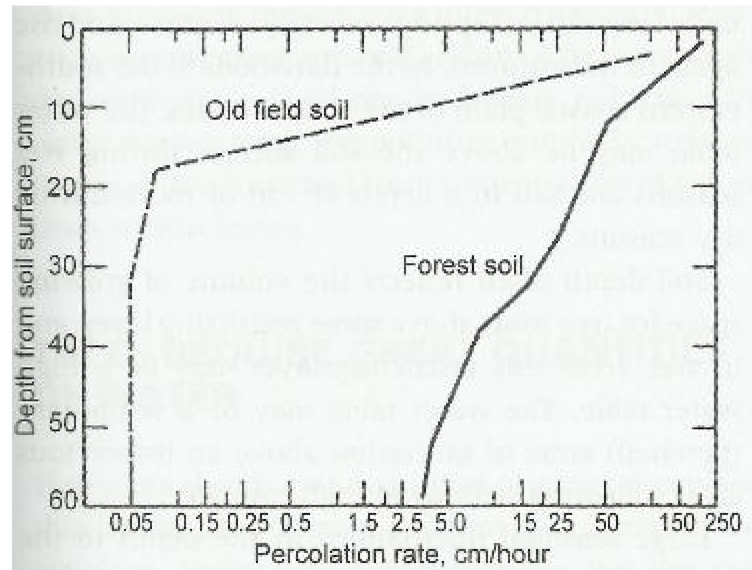
Forest Plantations versus Native forests..

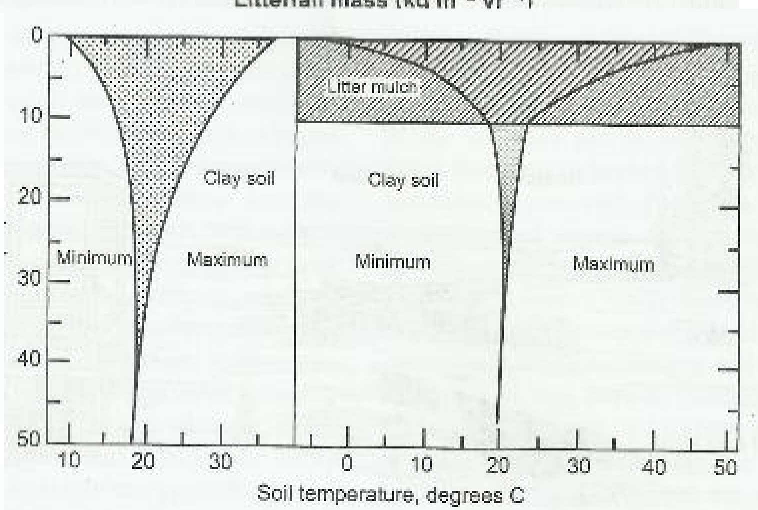
Large woody debris and leaf litter in soils also differ from native forest and tree plantations, what generates important differences on Horizon 0.

Binkley *et al.*, 1997



Forest soils improve infiltration to deeper soil layers.. (Hoover, 1949)





Horizon 0 buffers changes on soil (& soil-water) temperature (Cochran, 1969).

…Some key messages

- Native forest maturation (through secondary succession) is expected to reach a level of physical heterogeneity and biodiversity that will confer them a set of properties that are not going to be achieved by managed forests or tree plantations.
- Forest ecosystem maturation will propagate to the river ecosystem, producing an important stabilisation of its biodiversity and functioning.
- This has major implications for GIN design, especially when biodiversity conservation or regulating ecosystem services (e.g., drought/flood control, erosion control, C-sequestration, etc…) should be considered or enhanced in a given area/landscape in opposition to provisioning services (e.g. wood or food production).
- GIN design should favour rewilding of native forest in areas where regulating services are demanded in opposition to tree planting or active reforestation. When technical reasons force it (low probability of natural regeneration) a combination of innovative techniques should be deployed.
- When provisioning forest ecosystem services need to be enhanced traditional forestry practices and management should be reviewed to incorporate tree-soil-water ecological interrelationships (embracing ecological principles and not only productivity).


ALICE
Interreg
Atlantic Area
European Regional Development Fund
EUROPEAN UNION
Thanks a lot for your attention!