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E DELLA TUTELA DEL TERRITORIO E DEL MARE

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THE ALPINE CONVENTION IS THE FIRST INTERNATIONAL TREATY FOR THE PROTECTION AND PROMOTION OF THE SUSTAINABLE DEVELOPMENT OF A CROSS-BORDER MOUNTAINOUS REGION
italian presidency 2013-2014
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THE ROLE OF ECOSYSTEM SERVICES IN PLANNING ALPINE REGIONS:

THE ANALYSIS OF THE DISTRIBUTION OF FOREST ECOSYSTEM SERVICES IN TRENTINO

Marika Ferrari

DICAM - Università di Trento

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Fondo europeo agricolo per lo sviluppo rurale: l'Europa investe nelle zone rurali
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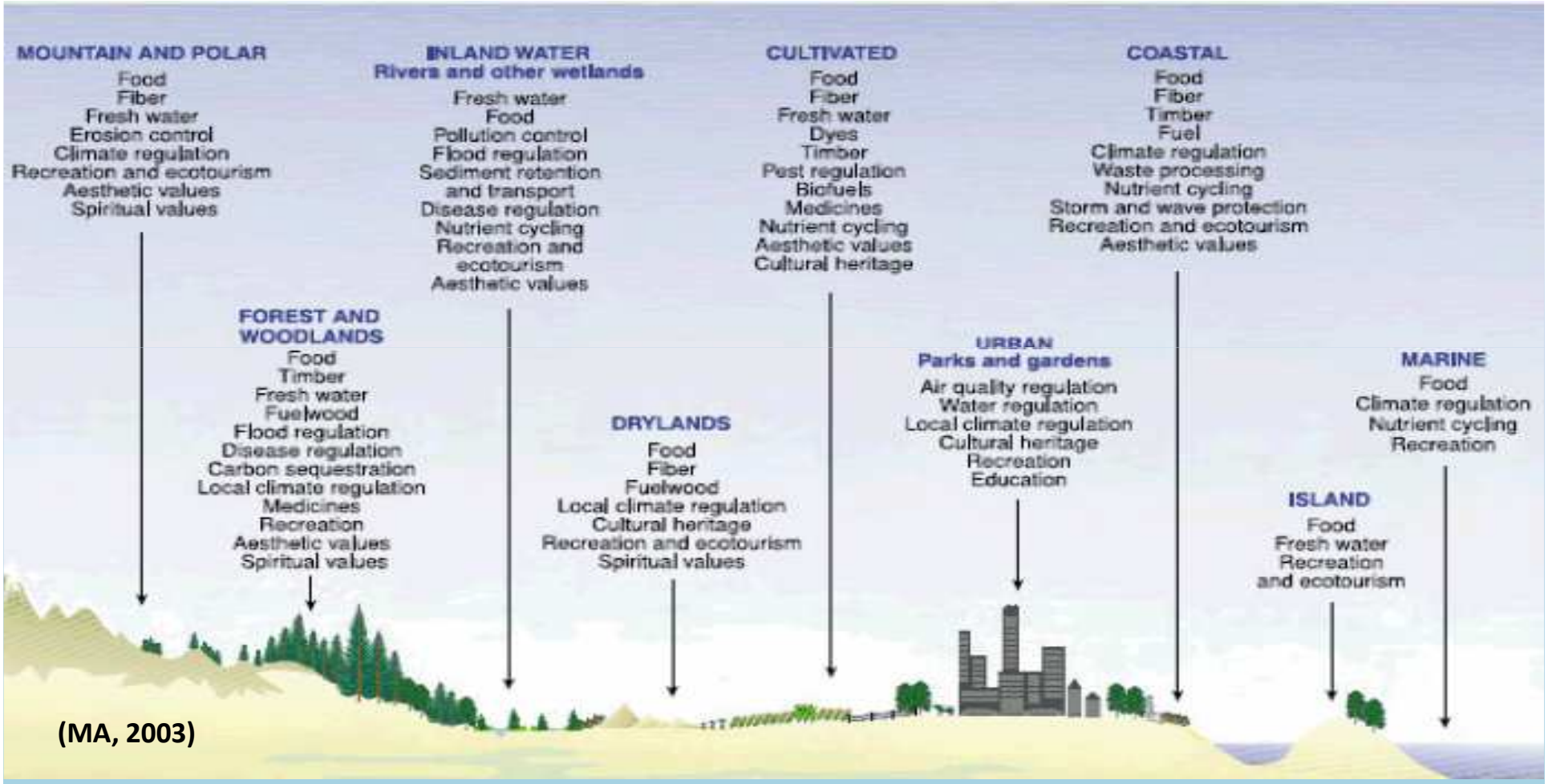
What are Ecosystem Services?

"**Ecosystem Services (ESs)** are the benefits people obtain from ecosystems" (MA, 2003)



"We depend upon ecosystem services for our health, our well-being and our economy."
(EPA, 2008)

INTRODUCTION

GREEN ECONOMY

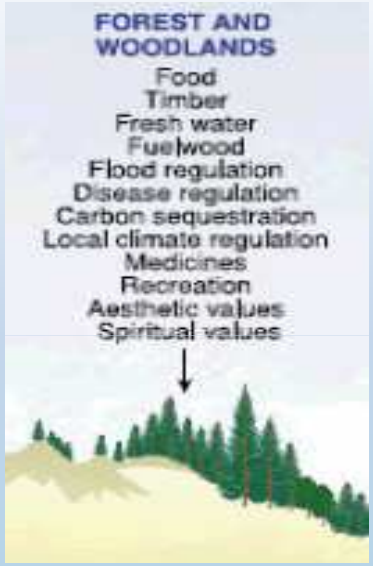
SUSTAINABLE USE OF TERRITORY

RATIONAL USE OF RESOURCES

ALPINE REGIONS

FOREST ECOSYSTEMS

ECOSYSTEM SERVICES



RATIONAL USE OF ECOSYSTEM SERVICES

1. Available ecosystem services
2. The values for inhabitants/stakeholders
3. Spatial distribution

PILLARS

1. Available ecosystem services

- **Forest** ecosystems provide a **large set of ecosystem services** that are both provisioning, regulating and cultural services
- A number of them are **typical of Alpine regions**
- A single **human activity** may **generate multiple ecosystem services** (e.g. food and enjoyment are generated contemporaneously by hunting)
- A number of them are exclusive of forests while some other may **belong also to other ecosystems** (e.g. carbon sequestration of agricultural lands)

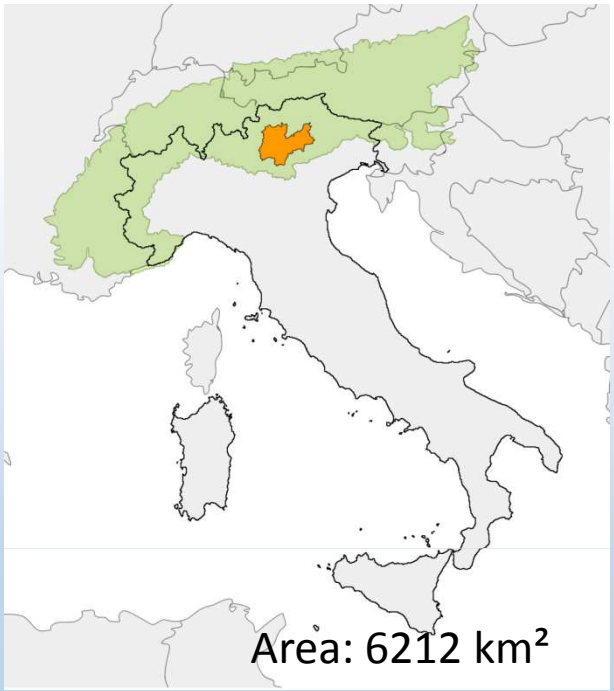
2.Values for inhabitants

- A single service may be **measured by biophysical, economic and socio-cultural values** (e.g. nutrition versus market price of timber production)

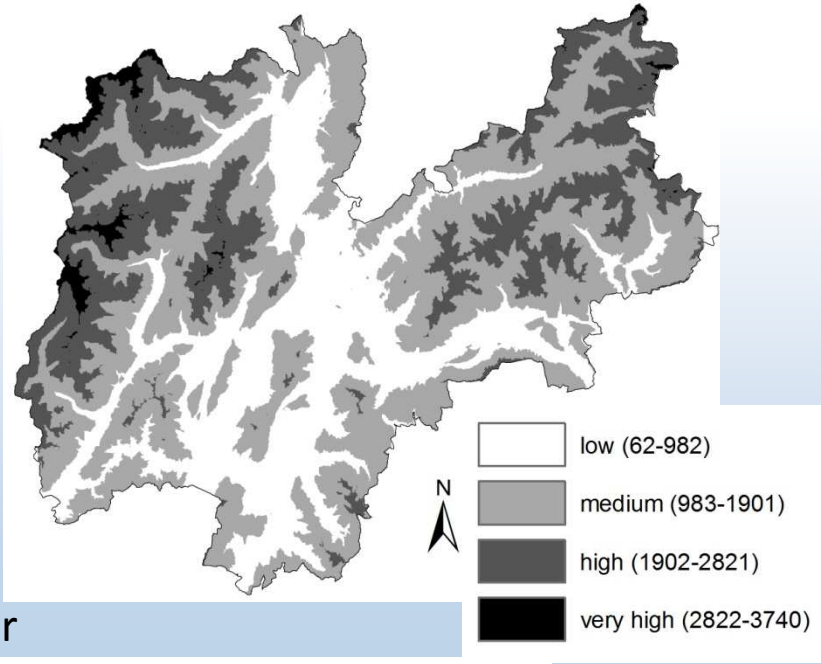
3. Spatial distribution

- Services are **not uniformly distributed across the territory** (e.g. timber production values are different across diverse forest parcels)
- The **spatial distribution is different**: timber production is on forest lots, while carbon sequestration on forest types
- Forests may be divided in different **classes** according to the spatial distribution **of multiple ecosystem services**, that depend on the values and the spatial units

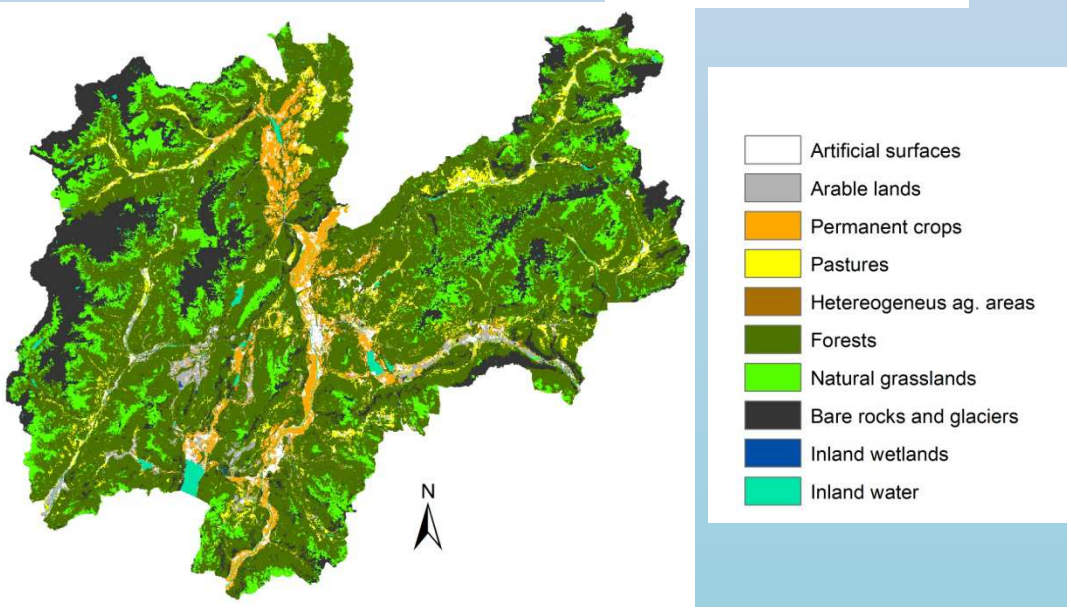
THE STUDY REGION: TRENTINO



Elevation



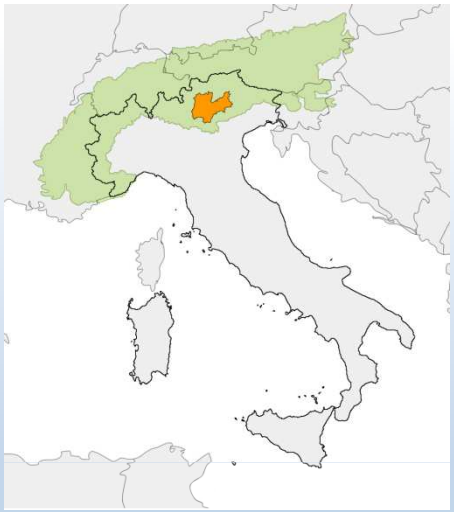
Land Cover



- Variegate territory
- Constituted of Semi-urbanized areas with large forests
- Inhabitants heavily use ecosystems and their services to ensure their wellbeing

Forest ecosystems provide a large set of ecosystem services:

18 types are provided by forests



ESs themes	ESs classes	ESs type
Provisioning	Food supply	Agriculture products
		Hunting products
		Fishing products
		Mushroom
		Honey
	Raw material supply	Inorganic matter
		Timber
	Energy supply	**Fuel wood**
	Water supply	Superficial network
		Groundwater

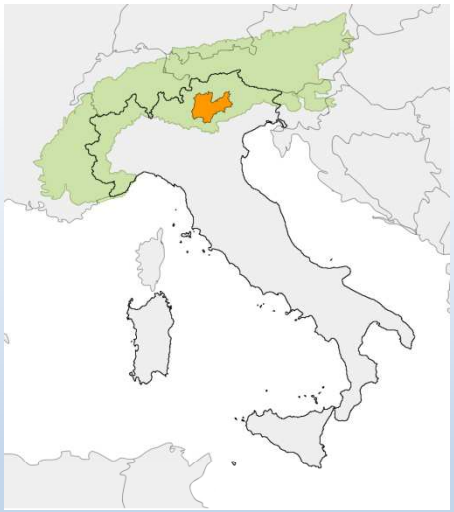
ESs themes	ESs classes	ESs type
Regulating	Water cycle regulation	Water quality
		Water flow
	Atmosphere components regulation	**Air quality**
		Microclimate
		Macroclimate
	Natural hazard regulation	**Flood, debris flow and avalanches**
		Flood

ESs themes	ESs classes	ESs type
Cultural	Opportunities for tourism	**Tourism**
		Scenic beauty
	Opportunities for downtime activities	**Hunting**
		Fishing
		Mushroom harvesting
		Honey collecting
		Sporting
		Relaxing

Classification framework: CICES (Haines-Young & Potschin, 2010)

Forest ecosystems provide a large set of ecosystem services:

One is typical of Alpine regions



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A single human activity may generate multiple ecosystem services

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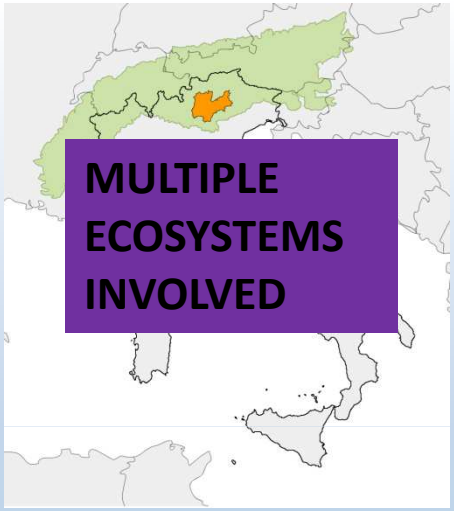
A number of them are exclusive of forests , while some other may belong also to other ecosystems



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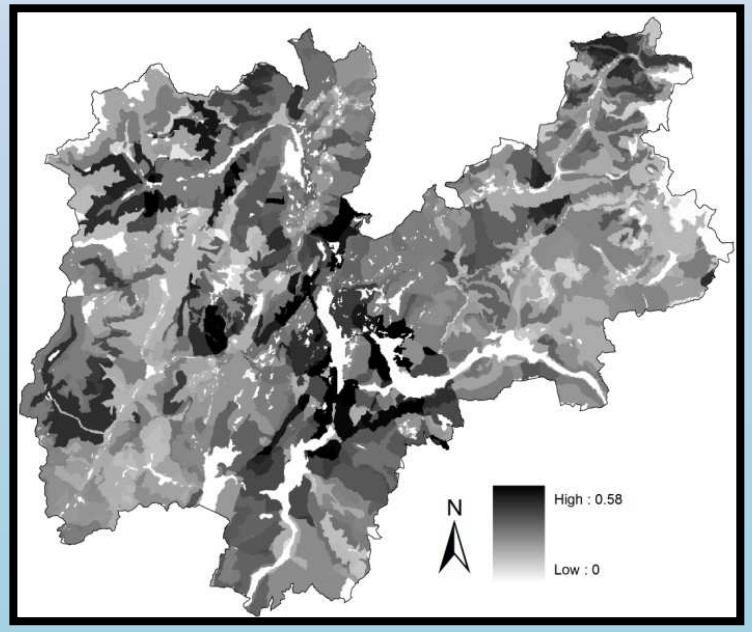
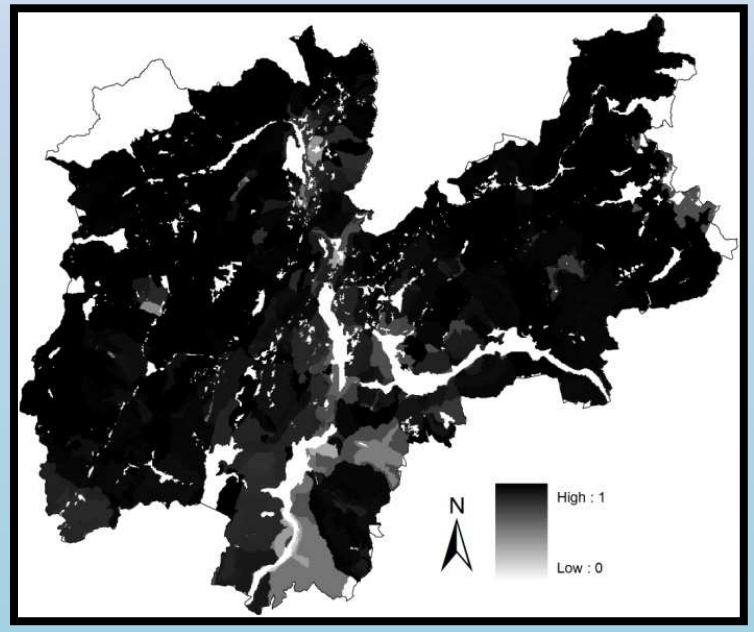
A single service may be measured by biophysical, economic and socio-cultural values

Provisioning service: Hunting production

Density of animals available for hunting	Meat of hunted animals	Nutritive value of hunted animals	Ratio of hunted animals belonging to ungulates
[n. of animals * ha^{-1}]	[kg * ha^{-1}* year^{-1}]	[kcal * ha^{-1}* year^{-1}]	[n. of hunted ungulates*n. of hunted animals^{-1}* year^{-1}]





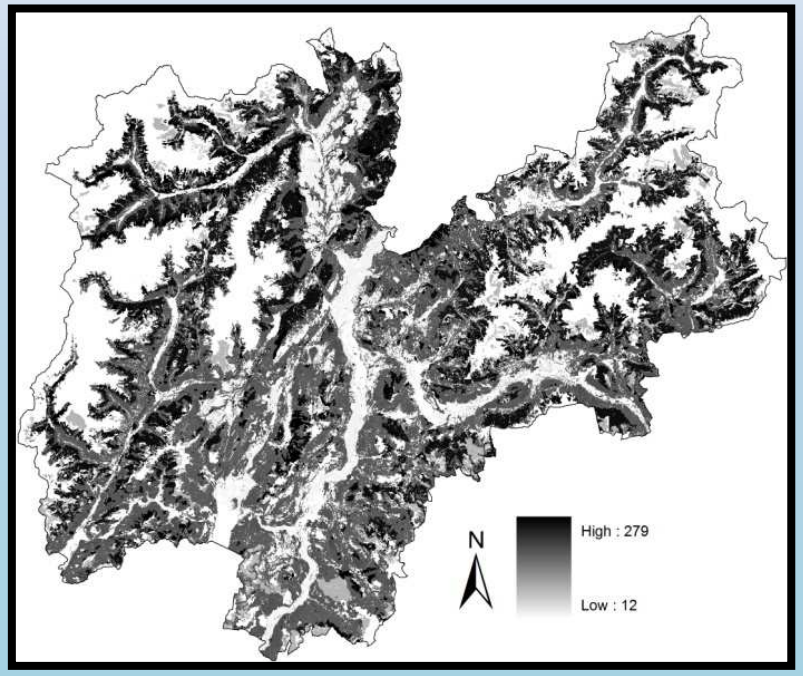
Data source: Servizio foreste e fauna; Associazione cacciatori trentini

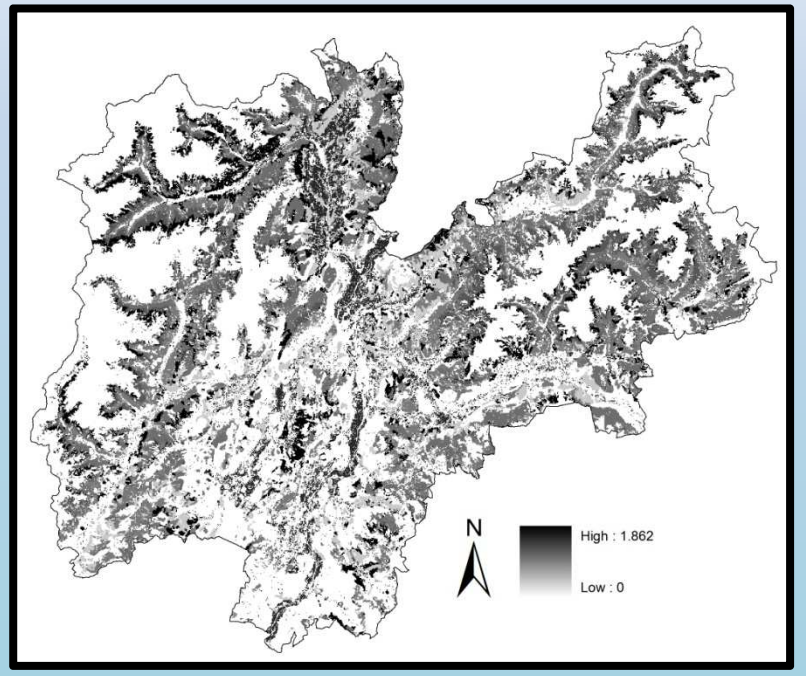
Services are not uniformly distributed across the territory

A single service may be measured by biophysical, economic and socio-cultural values

Regulating service: Macroclimate regulation

Carbon storage	Carbon increment
[t of carbon * ha^{-1}]	[t of carbon * ha^{-1}* $year^{-1}$]





Data source: Inventario provinciale del cabonio (2007), Centro di Ecologia Alpina

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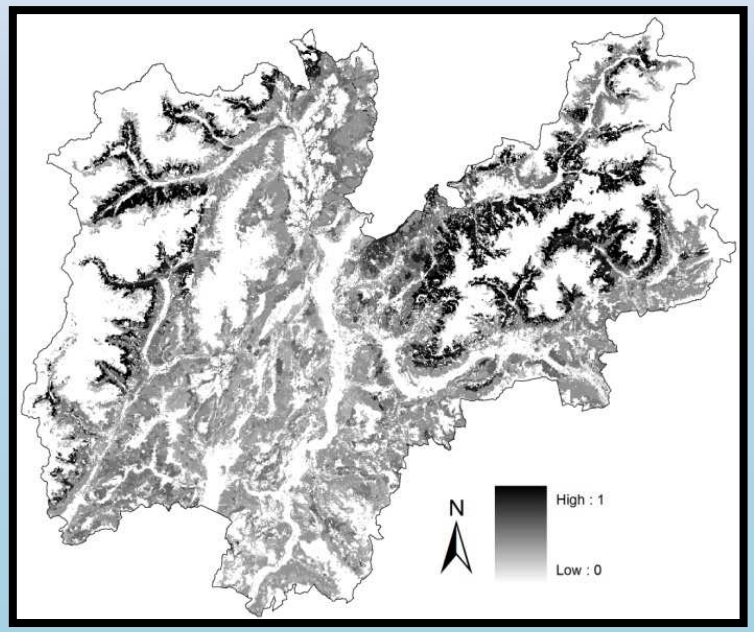
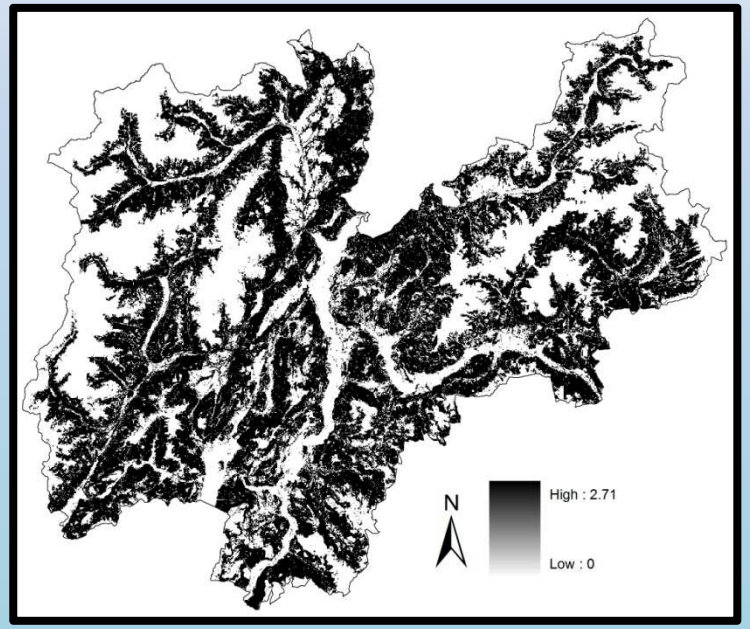
Cultural services: Mushroom harvest

Availability of mushrooms of good quality	Gain by harvesting authorizations
[-]	[€* ha^{-1}* $year^{-1}$]





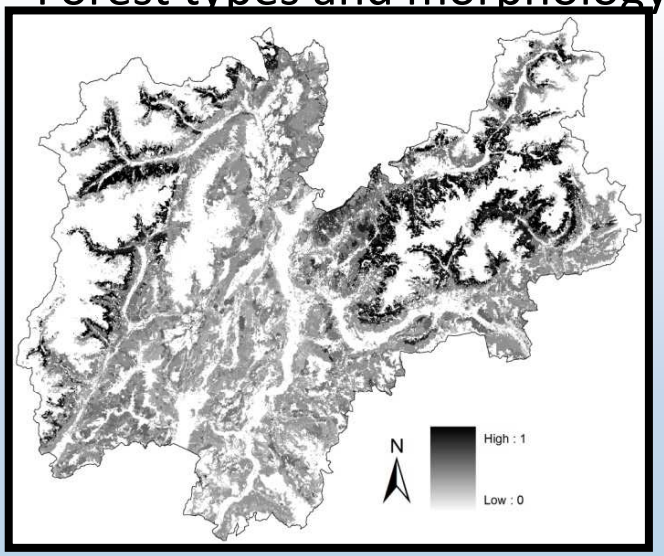
Data source: Dipartimento foreste

Services are not uniformly distributed across the territory

The **spatial distribution** of the forest ecosystem Services is different. **Spatial units** of forest ecosystem services are: **Forest types, forest lots, areas 500m/3km close to forest roads, hunting areas**

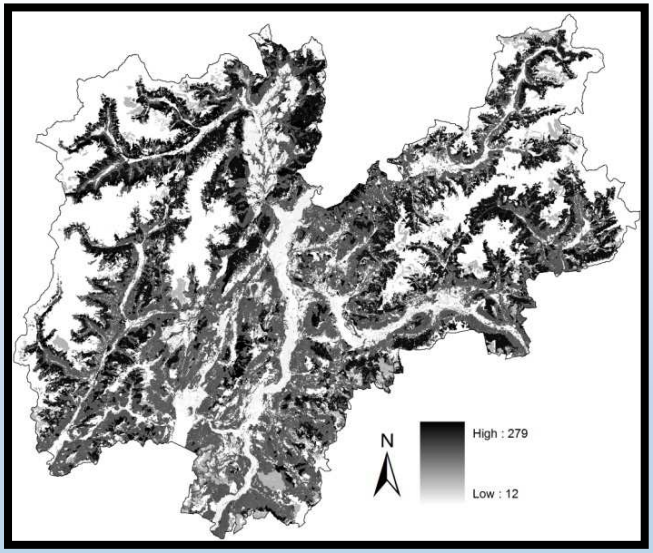
Availability of mushroom

Forest types and morphology



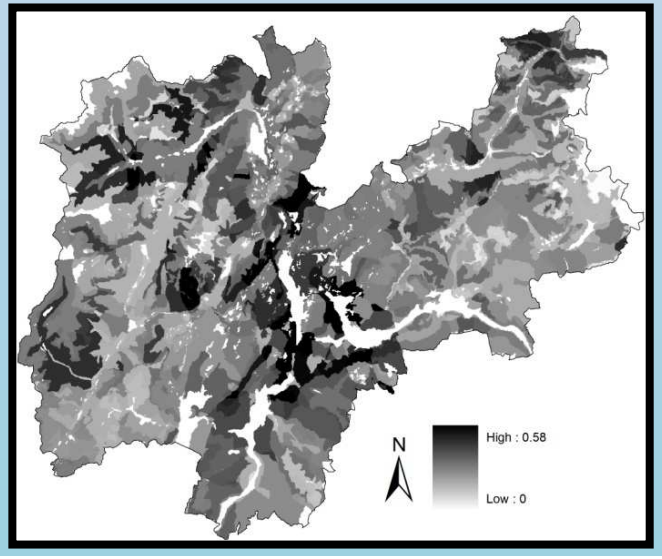
Carbon stock

Forest types



Density of animals

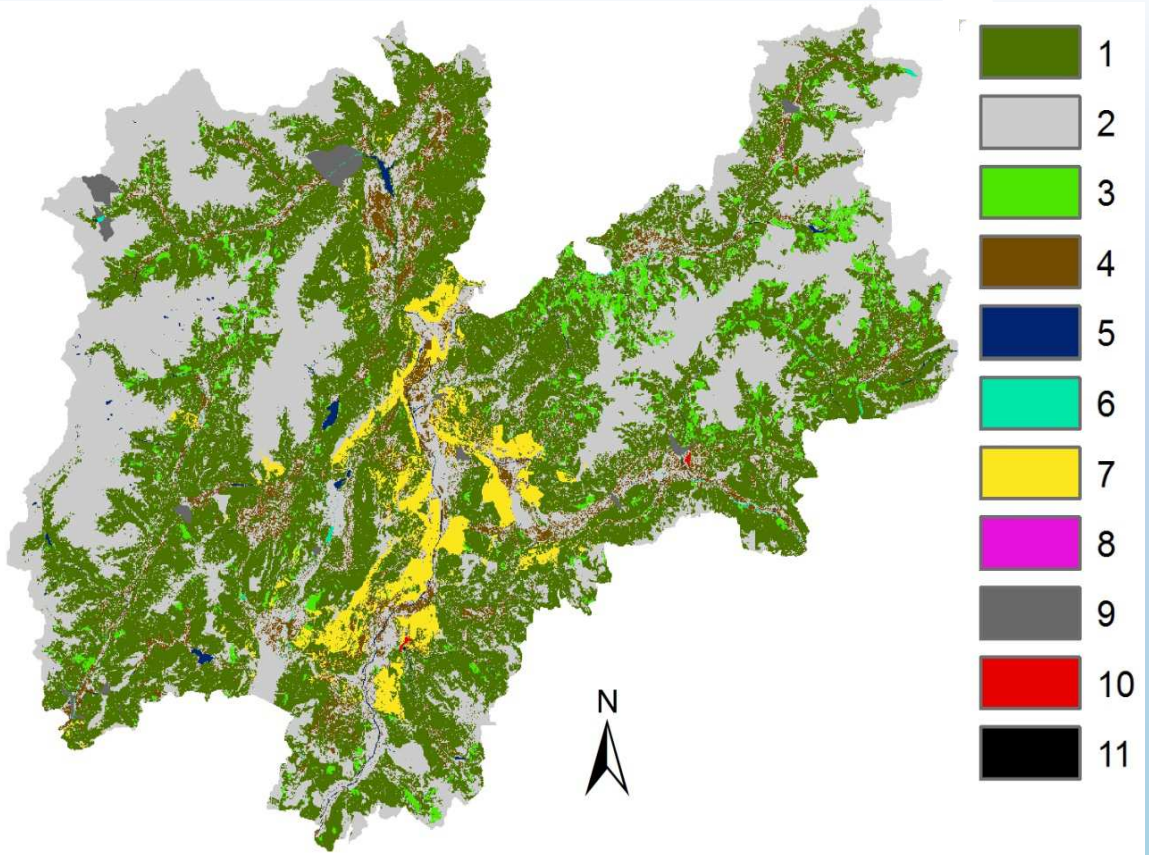
Hunting areas



Forests may be divided in different classes

25 **Ecosystems services** (18 were of forest) have been **grouped in 11 classes**, accordingly to the **spatial distribution** and the **values** of the services (cluster analysis)

Each class represent a set of services with some common characteristics:



1 **Most common Ess in forests**

2 Low-intensity and low-diversity ESs

3 **High-intensity and high-diversity ESs**

4 High intensity in agricultural areas

5 **High intensity recreation services in forests** and over water network

6 High water regulation capacity ESs

7 High-intensity human activity in semi-urbanized areas

8 Few but high-intensity ESs

9 Several but low-intensity ecosystem services

10 High-intensity regulating services

11 **Ess in low-elevation .forests**

Class 1 contains 90% of Forests with distribution up to 2800 m.s.l.m. All forest Ess are supplied

90% is of forest in Cluster 3 and 11

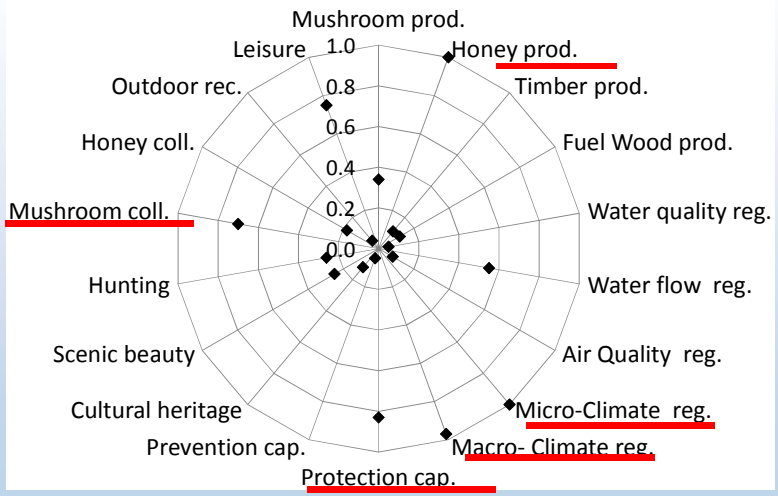
Cluster 3 essentially correspond to forest areas of Valle di Fiemme (timber production

Forests may be divided in different classes

Each class (cluster) represent a set of services with some common characteristics:

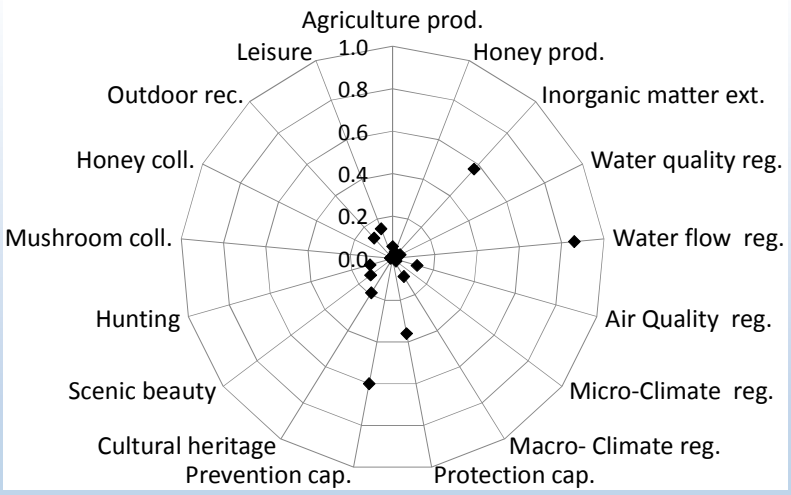
Most common ESs in forests

Cluster 1



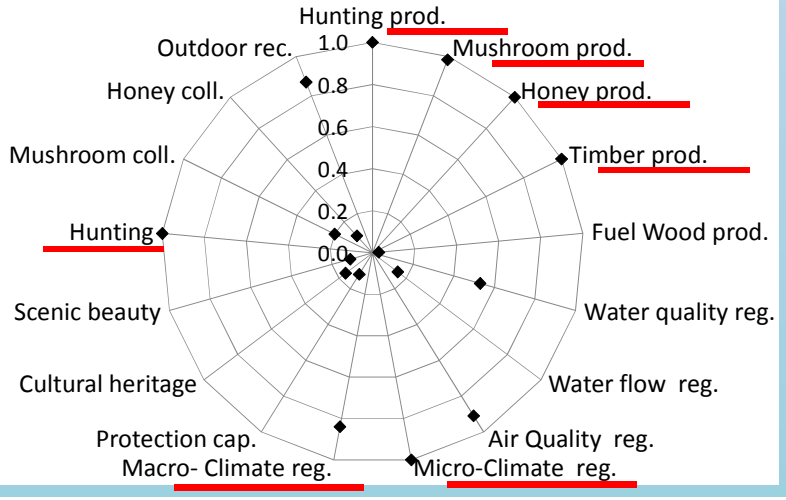
Low-intensity and low-diversity ESs

Cluster 2



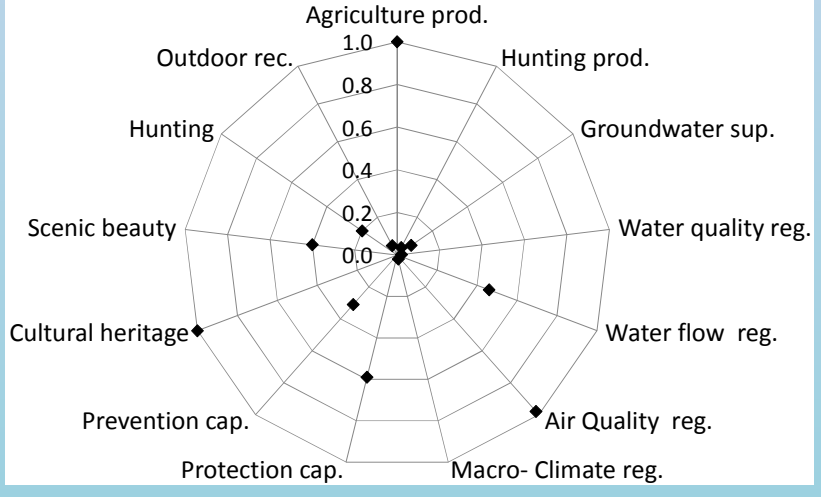
High-intensity and high-diversity ESs

Cluster 3



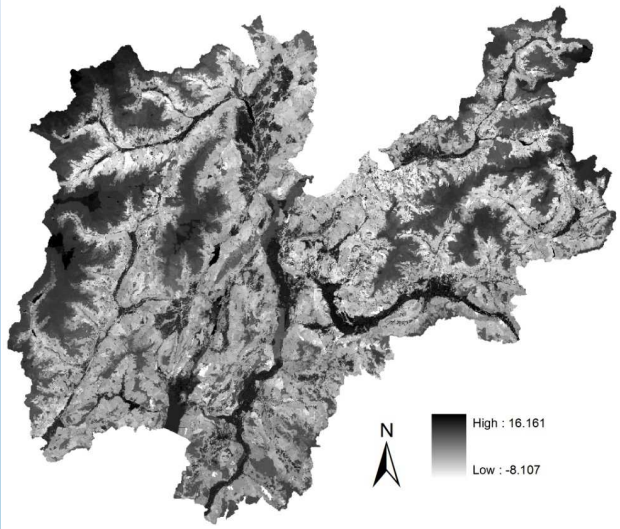
High intensity in agricultural areas

Cluster 4

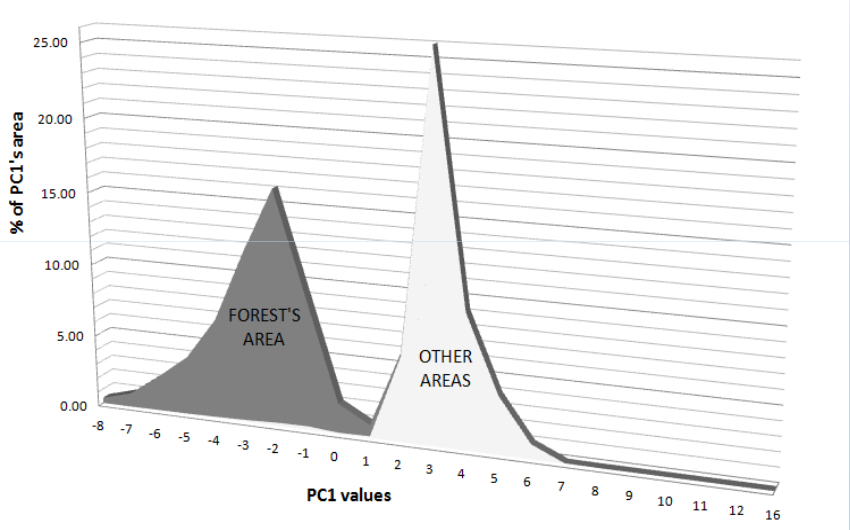


Forest ecosystem services are those with the highest variability across the region

First Principal Component: combination of ecosystem services value that represent the highest variability of the set of ecosystem services



Low values correspond to forest areas; highest values to artificial areas.



The **density of vegetation** characterizes the **variability of ecosystem service** distribution across the region

Great **loss of ecosystem services** is associated to the initial or the complete **conversion of forests** to different ecosystems

Methods and materials

- Involvement of **51 experts** of the **22 local administrative offices and research institutes**

- List of Maes et al. (2011): **An European atlas of ecosystem services**
- Common International Classification of Ecosystem Services **CICES** (Haines-Young and Potschin, 2010a)
- 19 peer reviewed papers with lists of indicators

- Statistical analysis (Cluster and Principal Component analysis)

- **Existing and available data**
  - ❑ real supply
  - ❑ stock and flow
  - ❑ biophysical, economic and socio-cultural value
  - ❑ first decade of 2000
  - ❑ Spatial heterogeneity

For a rationale use of forest ecosystem services…

- Remember that when managing forests several **resources** may be provided at once, but an ecosystem service exists only if it is **used by people**
- Look for **specific services** provided by Alpine forests
- Prefer human activities that may generate more services at once
- Consider the **other ecosystems** and that they may contribute together with forest to provide a service
- Take in mind that the value of the services depends on the **stakeholders' priorities and opinions**, i.e. on the importance for their wellbeing

For a rationale use of forest ecosystem services…

- **Assess services** on the basis of their **extrinsic and intrinsic heterogeneity** in the spatial distribution of ecosystem services: it depends on the **spatial units** and on the **specific values** of the services in such units

- Consider that forests in **different locations** may provide **different sets of ecosystem services**, accordingly to the values and the spatial units of single ecosystem services

- Check whether great **loss of ecosystem services** is associated to **conversion of forests** into different ecosystems

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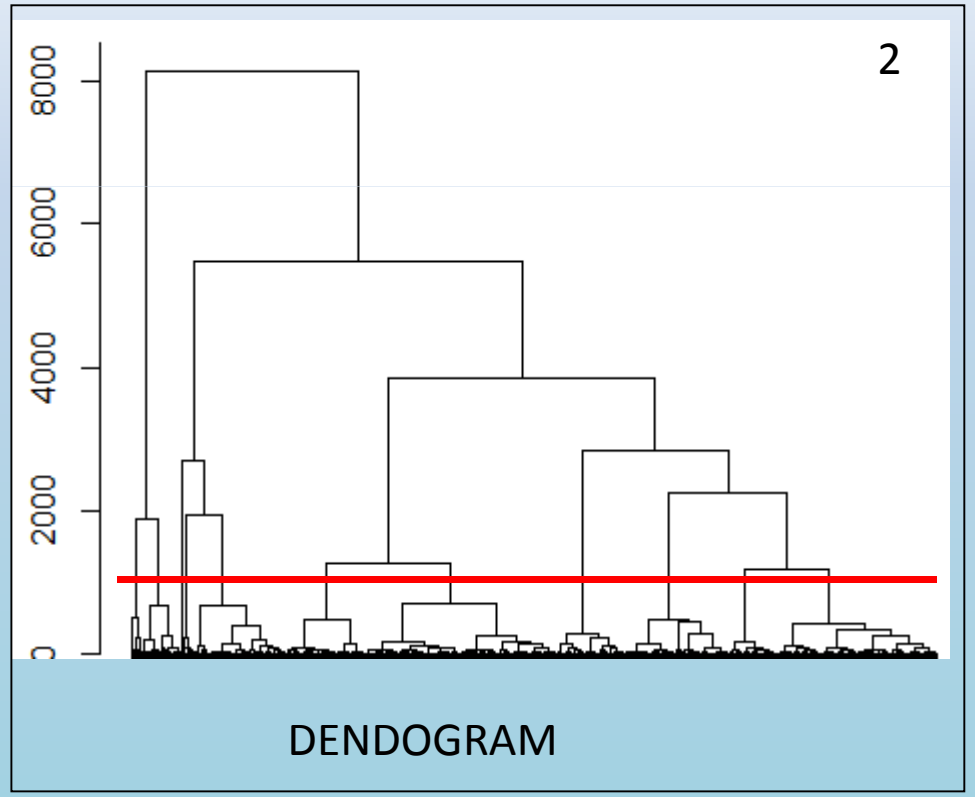
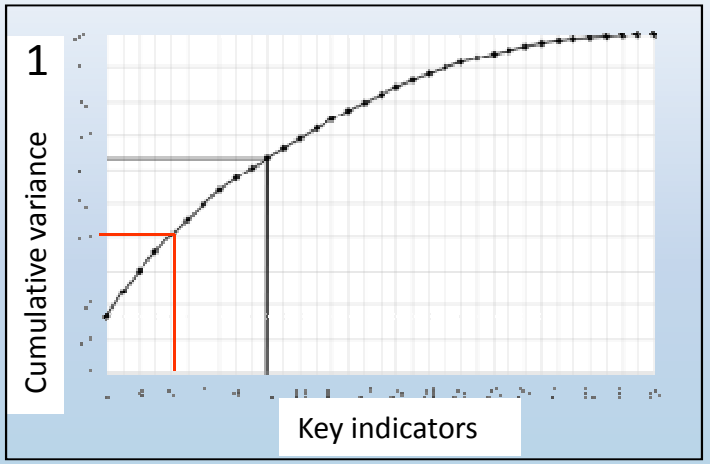
Ob3: Defining bundles of Ecosystem Services

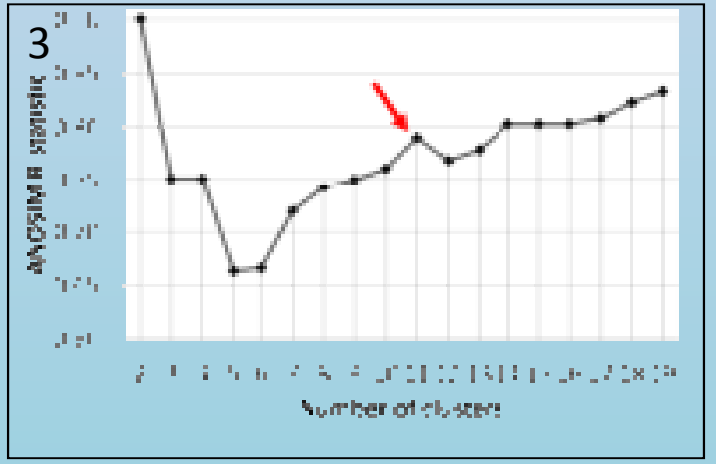
Identification of principal components and clusters of ecosystem services

1) Principal Component analysis -> to synthesize 35 indicators
2) Hierarchical Clustering on Principal Components -> identify clusters (i.e. ESs units)
3) ANalysis Of SIMilarity (ANOSIM) on clusters -> select the proper number of cluster



DENDOGRAM





Workshop

"The services of the Alpine forests ecosystems as a natural, economic and cultural asset for a regional and European green economy"

Pieve di Cadore (BL)
12 September 2014