Practical considerations to build up socio-economical scenarios for local eco-hydrological studies

INFORMED - Workshop on methodologies to design global change scenarios (GCS) for the Mediterranean forests

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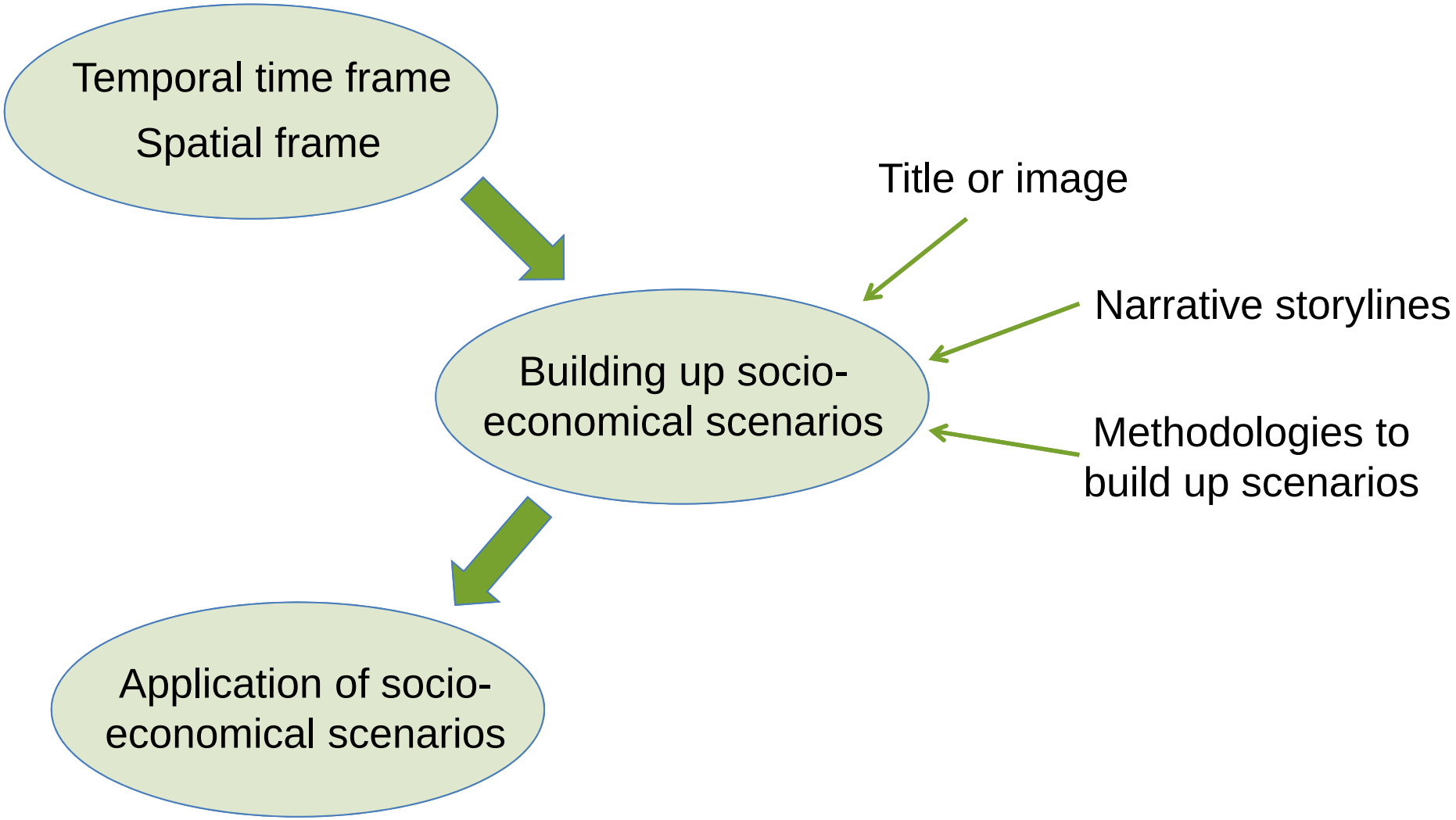
Solsona,
2nd December 2015

General approach



1.1. Definition of the temporal time frame

- Based on current **national o supranational projections**:
  - Demographic projections
  - Economical development

- Consider **territorial policies** affecting the area
  - Land planning
  - Water use management
  - Irrigation plans

Consider:

- Long temporal time frames → less capacity to predict reliable changes
- Short temporal time frames → difficult to see changes when comparing with the baseline

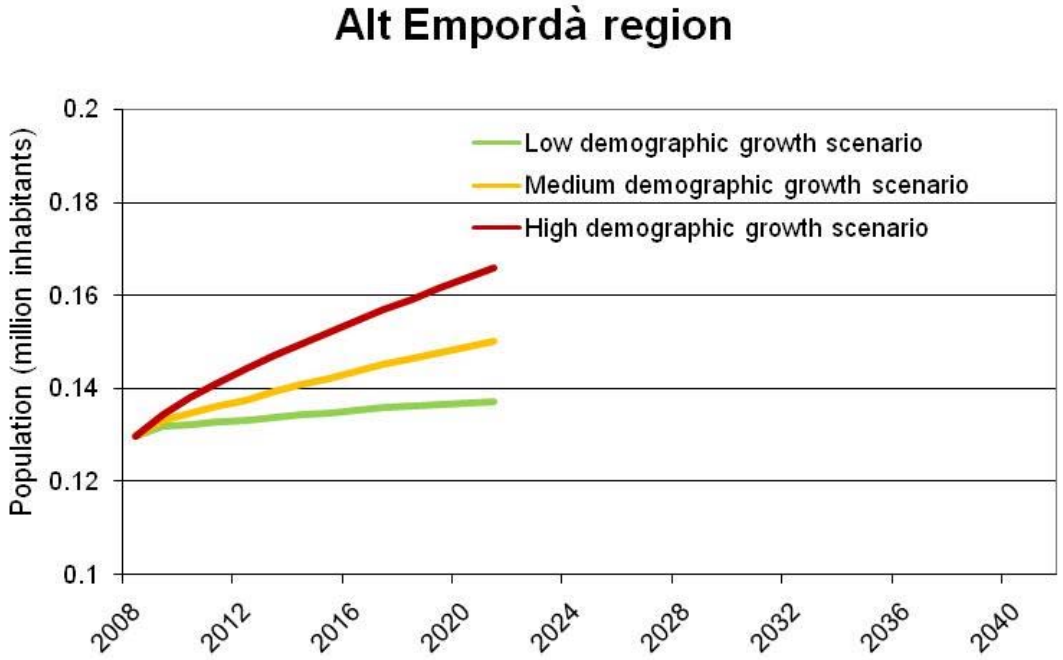
1.1. Definition of the temporal time frame

2030 (with 2005 as baseline)

1. Demographic projections – IDESCAT

   Catalan level - 2040

   Regional level - 2021



1.1. Definition of the temporal time frame

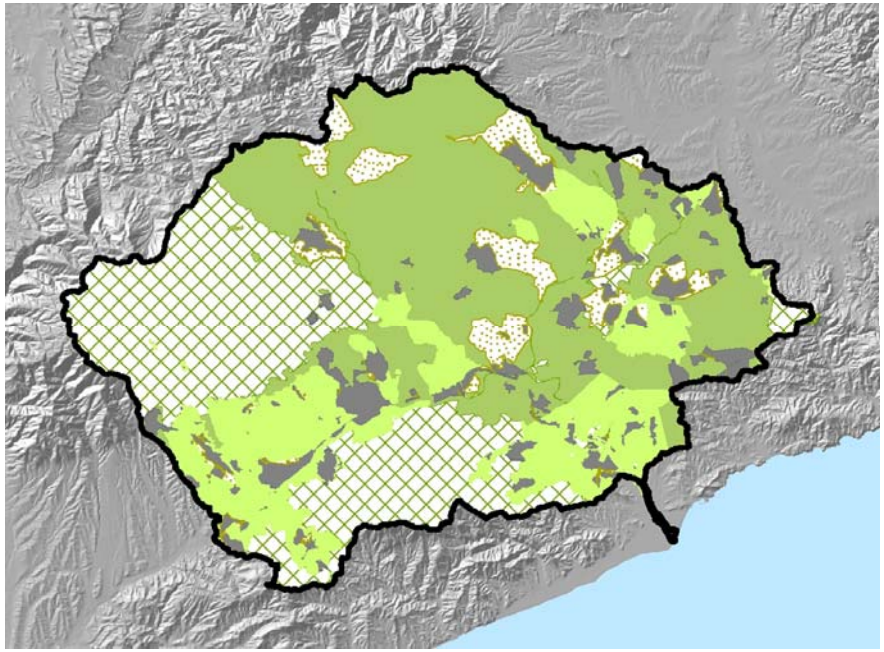
2030 (with 2005 as baseline)

2. Land planning

Partial territorial plans - 2026: Definition of:

- Land use distribution to control urban development and to protect natural areas
- Urban population strategies to control population growth
- Future infrastructures

Urban areas
PEIN – Nature 2000 network
Special protection
Territorial protection
Preventive protection



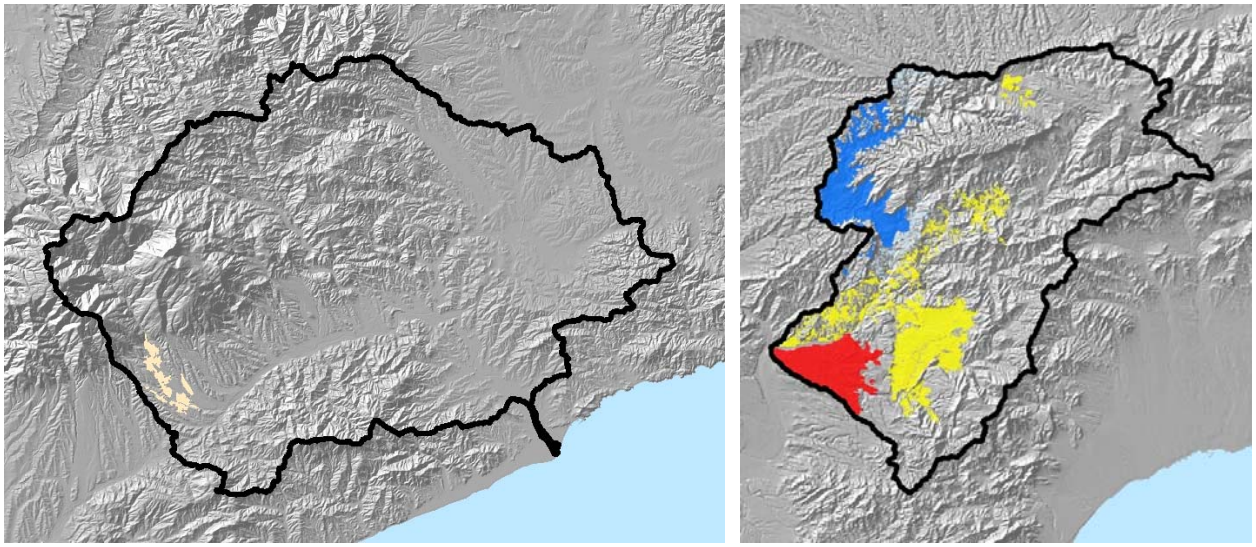
1.1. Definition of the temporal time frame

2030 (with 2005 as baseline)

2. Land planning

Irrigation infraestructures:

- Current and future construction of irrigation infrastructures



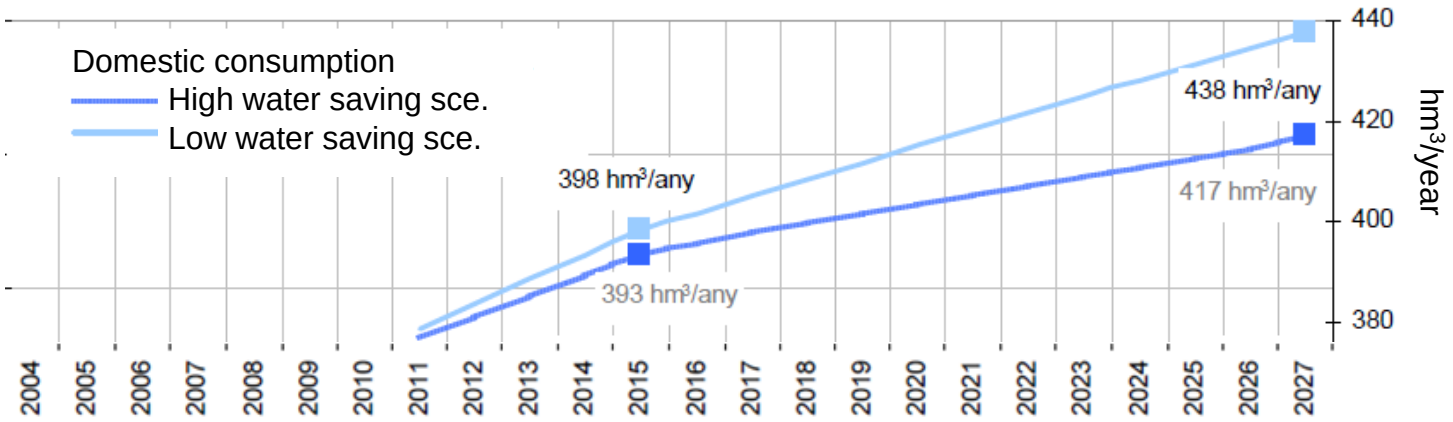
1.1. Definition of the temporal time frame

2030 (with 2005 as baseline)

3. Hydrological planning

Catalan River Basin District Management Plan – 2027

- Two scenarios: high and low water saving scenarios



1.2. Definition of the spatial frame

- Based on:
  - **Objectives** of the study: national or regional, river basin, ...
  - Area that allows to **analyse basic processes** and to evaluate its **response facing changes**
  - Spatial level of the available information

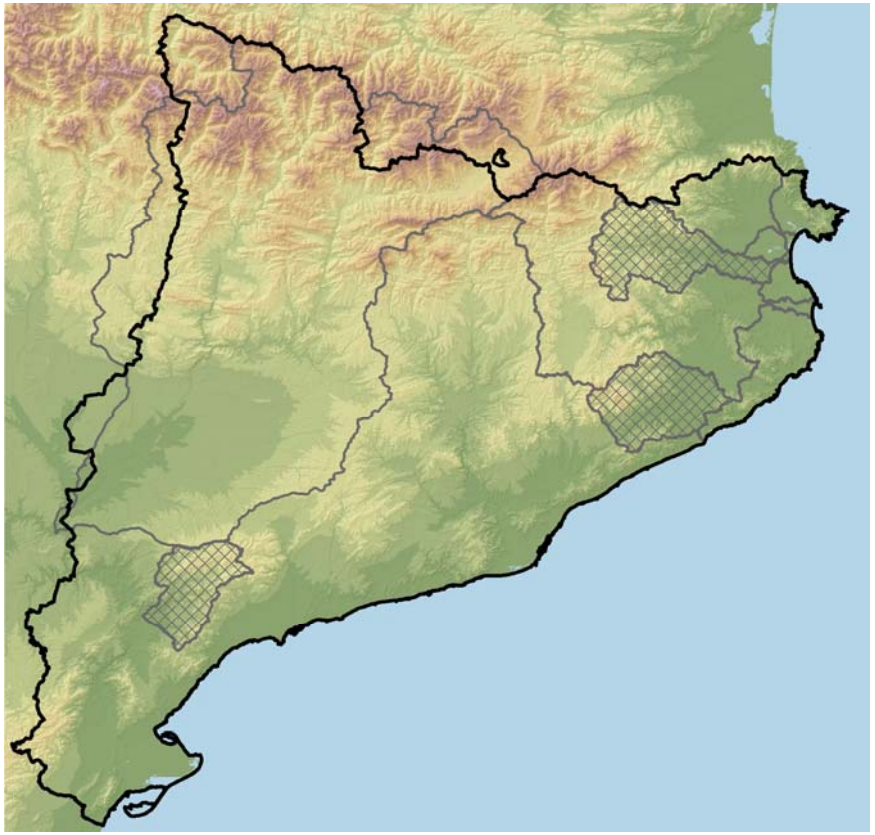
1.2. Definition of the spatial frame

River basin as unit of study

- Similar surface
- Latitudinal gradient in climatic conditions
- Internal diversity in in environmental conditions, pressures and water demands
- Non regulated river basins

1.2. Definition of the spatial frame

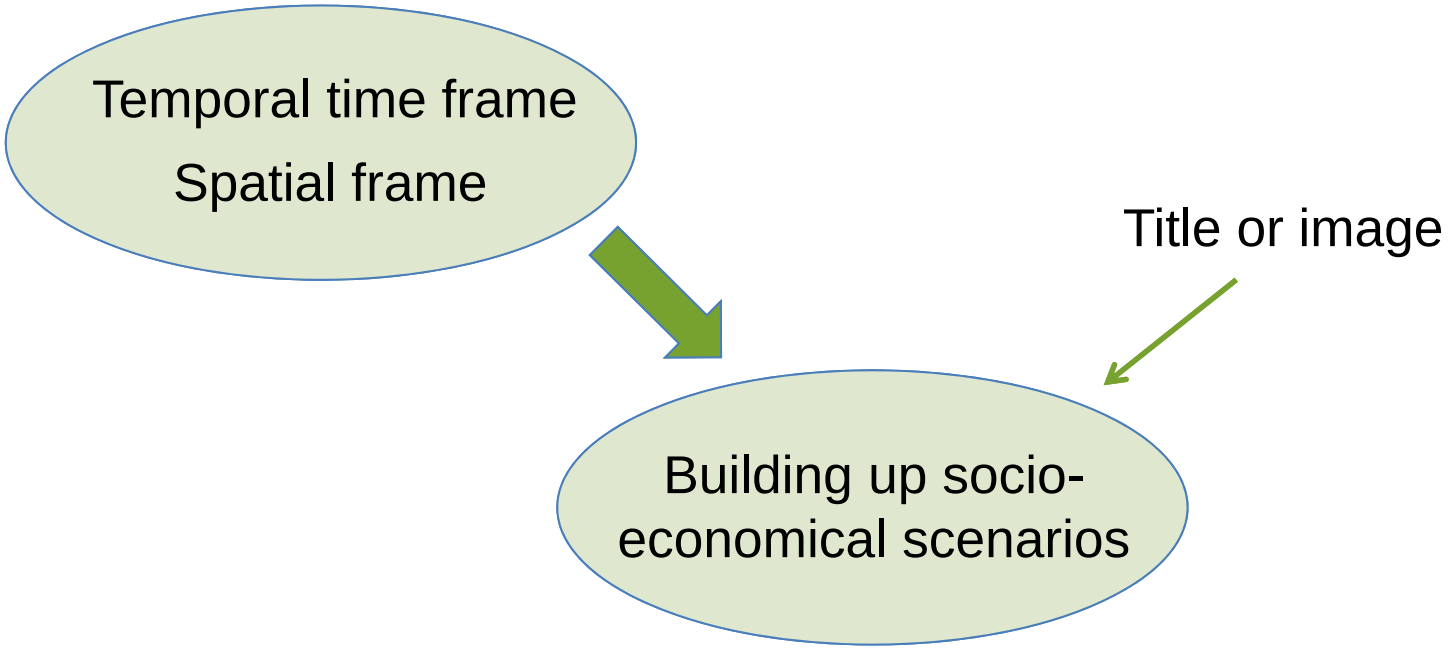
MEDACC
Adapting the Mediterranean to climate change



River basin as unit of study

- Unstudied river basins
- Share a common structural water deficit to supply all demands whereas ensuring ecological stream flows
- Availability of data

General approach



2.1. Building up scenarios – Title and image

- Based on:
  - **Global or regional socio-economical** scenarios: IPCC, UNEP, OECD, European projects (ALARM, ESPON, PRELUDE, ….)
  - Concrete **characteristics of the study area**: land use distribution, water uses, ...
  - **Expert knowledge** on main socio-economical sectors

Consider:

➢ Contrasted scenarios to see differences

2.1. Building up scenarios – Title and image

ACCUA

Scenarios based on different socio-economical developments

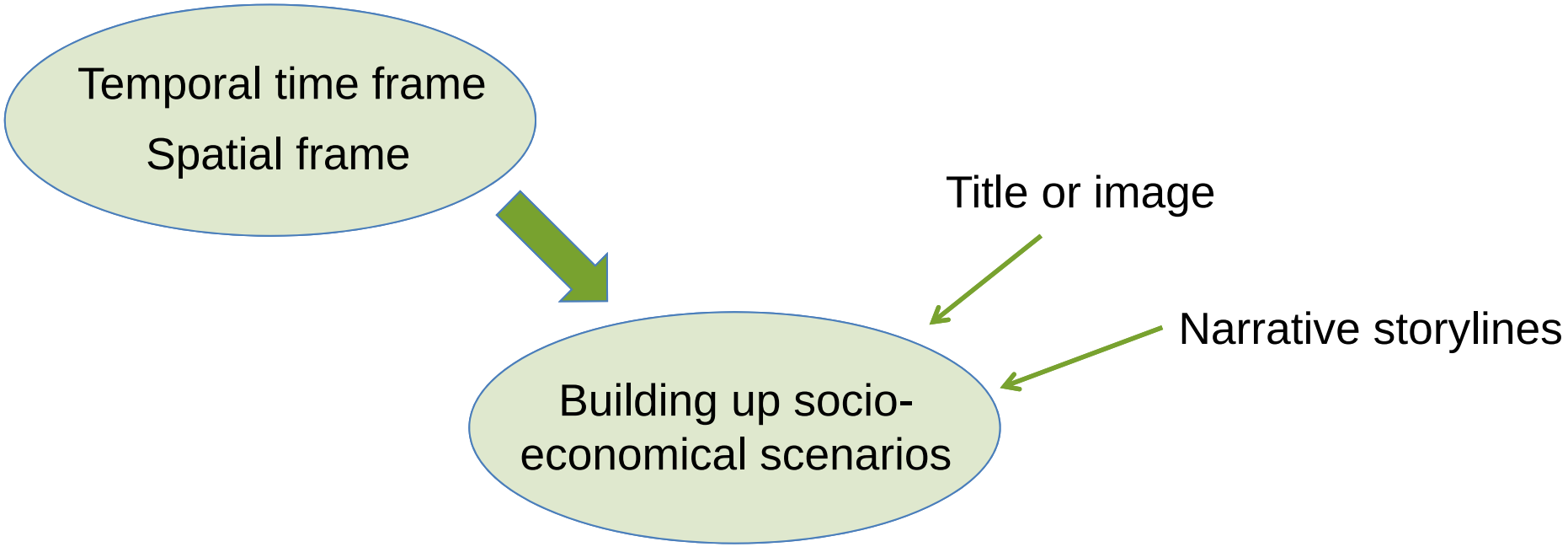
- **Trend scenario**: maintenance of development trends of last decades
- **Sustainable scenario**: management strategies headed towards adaptation and reduction of climate change effects

MEDACC
Adapting the Mediterranean to climate change

Scenarios based on different adaptation strategies at river basin level

- **On forest areas**: Main land cover (63-75% of surface)
- **On water uses**

General approach



2.1. Building up scenarios – Narrative storylines

- Definition of the **general socio-economical context**
- Identification of **socio-economical and environmental impacts** of the scenarios
- Translation of the general context **to the local conditions** of the study area based on **interviews and meetings with key stakeholders**

Consider:

- Coherence with the most recent global or regional socio-economical scenarios
- The translation of the general storyline to the local context can produce different dynamics in different basins

2.1. Building up scenarios – Narrative storylines

ACCUA

Trend scenario

- **General context**:
  - Fast economic growth
  - High demographic growth
  - Intensive use of fossil fuels
  - Globalization

- Translation to **local conditions**:
  - Fluvià : urban pressure increment (coast line), agricultural abandonment
  - Tordera: urban pressure increment (medium water course), agricultural concentration
  - Siurana: population maintenance, agricultural abandonment and intensification, execution of irrigation plan

2.1. Building up scenarios – Narrative storylines

Sustainable scenario

- **General context**:
  - Moderate economic growth
  - Moderate demographic growth
  - Restraint of energy consumption

- Translation to **local conditions**:
  - Fluvià and Tordera: moderate population growth, urban restructuration
  - Siurana: rejuvenation of population, agricultural adaptation and reconversion, no development of the irrigation plan

2.1. Building up scenarios – Narrative storylines

Adapting the Mediterranean to climate change

Zoning of scenarios

- **Headwater scenarios**: Changes on forest areas:
  - AFOR: aforestation scenario, increasing forest area
  - FIREFOR: fire occurrence, reducing forest area
  - MANAGEFOR: implementation of forest management, changing forest structure
  - MOSAIC: recuperation of open areas and agro-forest mosaic

- **Medium and low course scenarios**: Changes on water uses:
  - RATUSE: rational use of water resources
  - HIGHDEMAND: increase of water demands

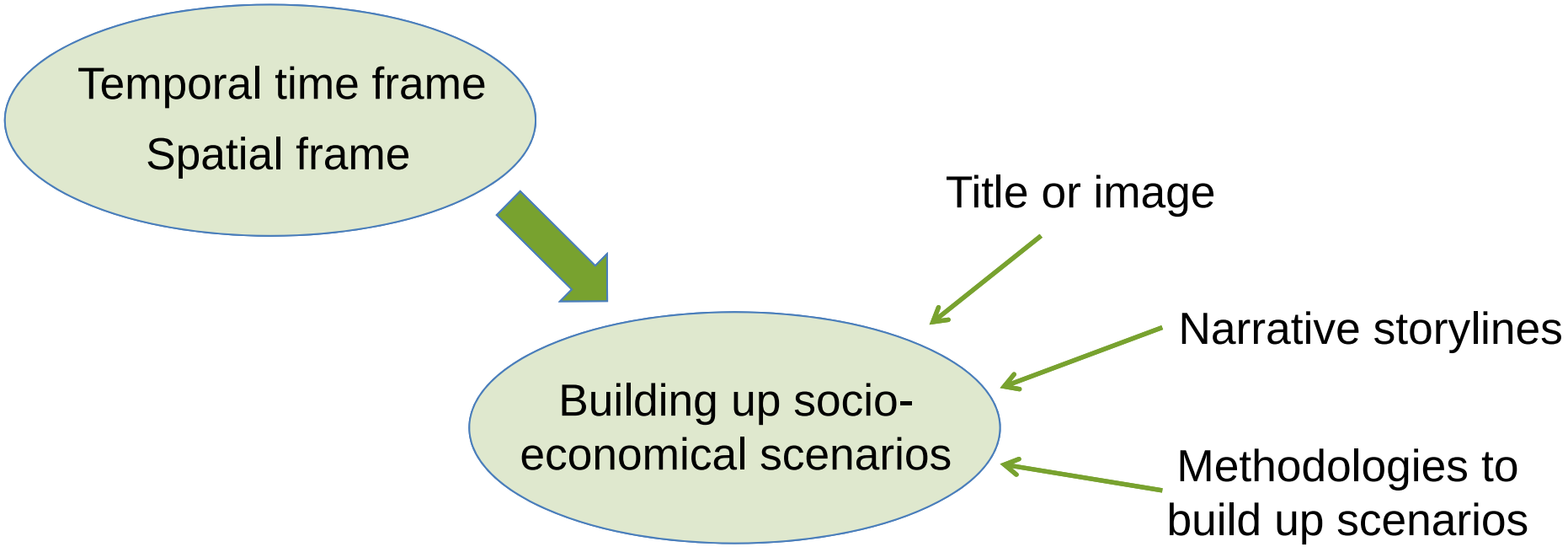
2.1. Building up scenarios – Narrative storylines

Adapting the Mediterranean to climate change

Scenarios development through

- **Focus group** meetings with key stakeholders
- **Expert knowledge** of the project partners in the three main sectors of the project: water management, forest and agriculture sectors.

General approach



2.1. Building up scenarios – Methodologies

- Definition of required **outputs**: maps, data, …
- Recompilation of **past data** to analyse the evolution
- Selection of the **methodology** to build up the scenarios: land change models, GIS tools, tables ...

Consider:

- Questions to answer with the scenarios to define the outputs
- Uncertainties associated to the use of models and methodologies

2.1. Building up scenarios – Methodologies

Two required outputs:

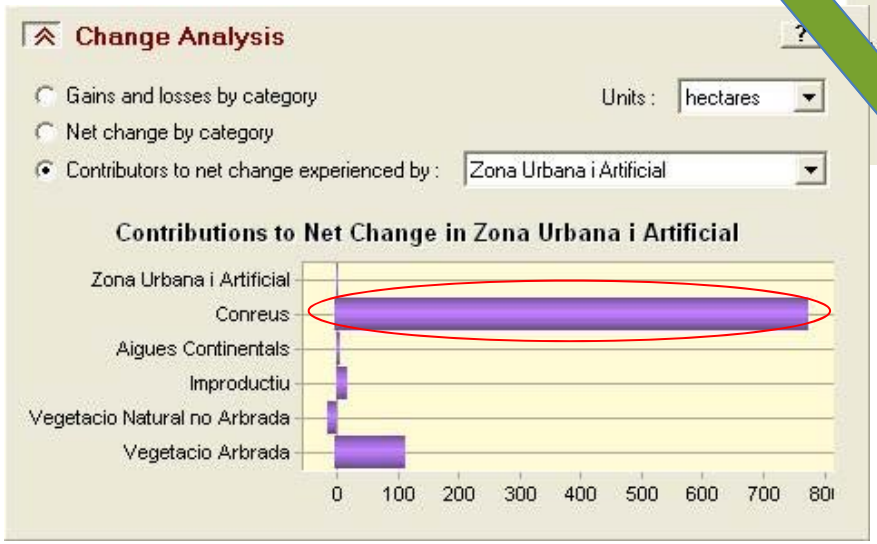
- **Land use cover for 2030:** Application of the Land Change Modeler (LCM) Extension of IDRISI

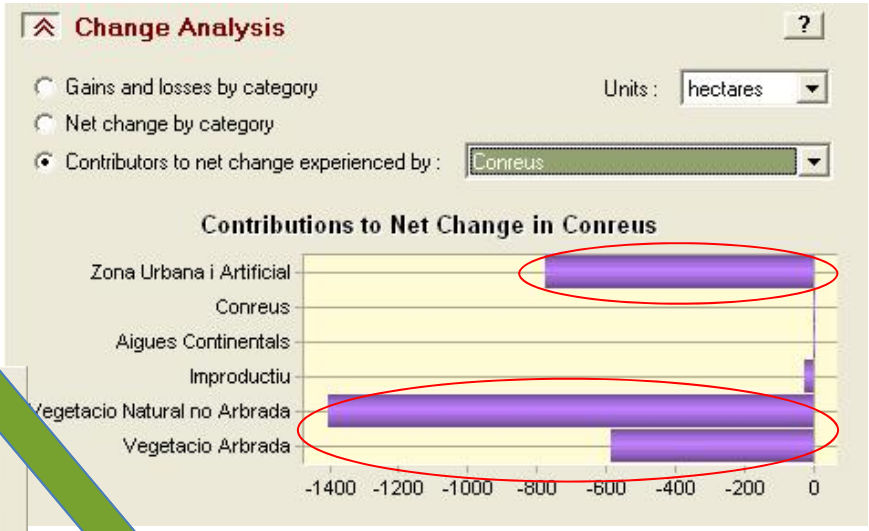
2.1. Building up scenarios – Methodologies

2030 Land use cover

Analyse changes between 1993-2000 land use covers

Changes in urban area class





Changes in crop class

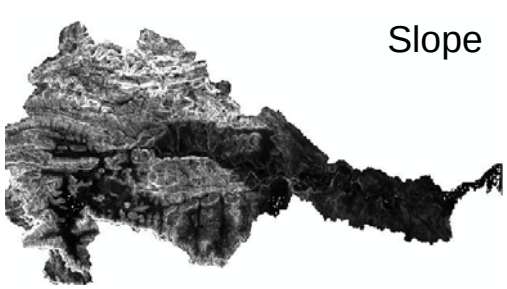
Detect main **occurred processes**

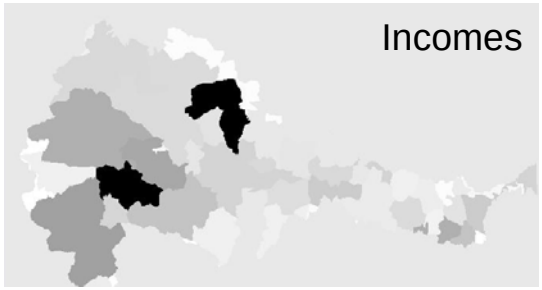
- Urban sprawl
- Agricultural land abandonment + aforestation

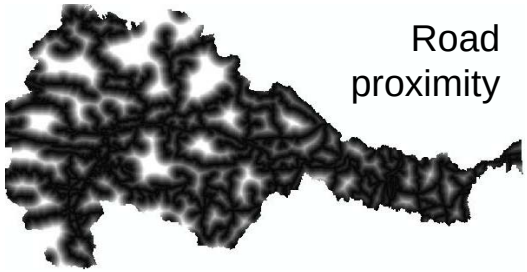
2.1. Building up scenarios – Methodologies

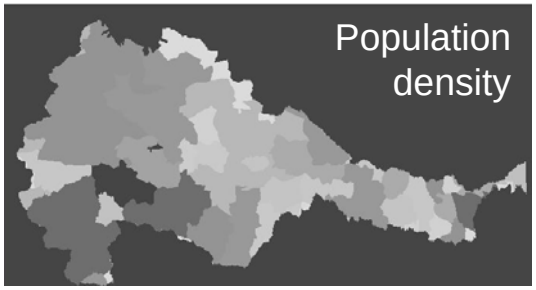
2030 Land use cover

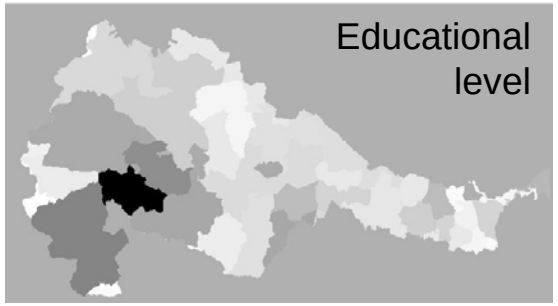
Selection of **variables that explain** main changes → Urban sprawl







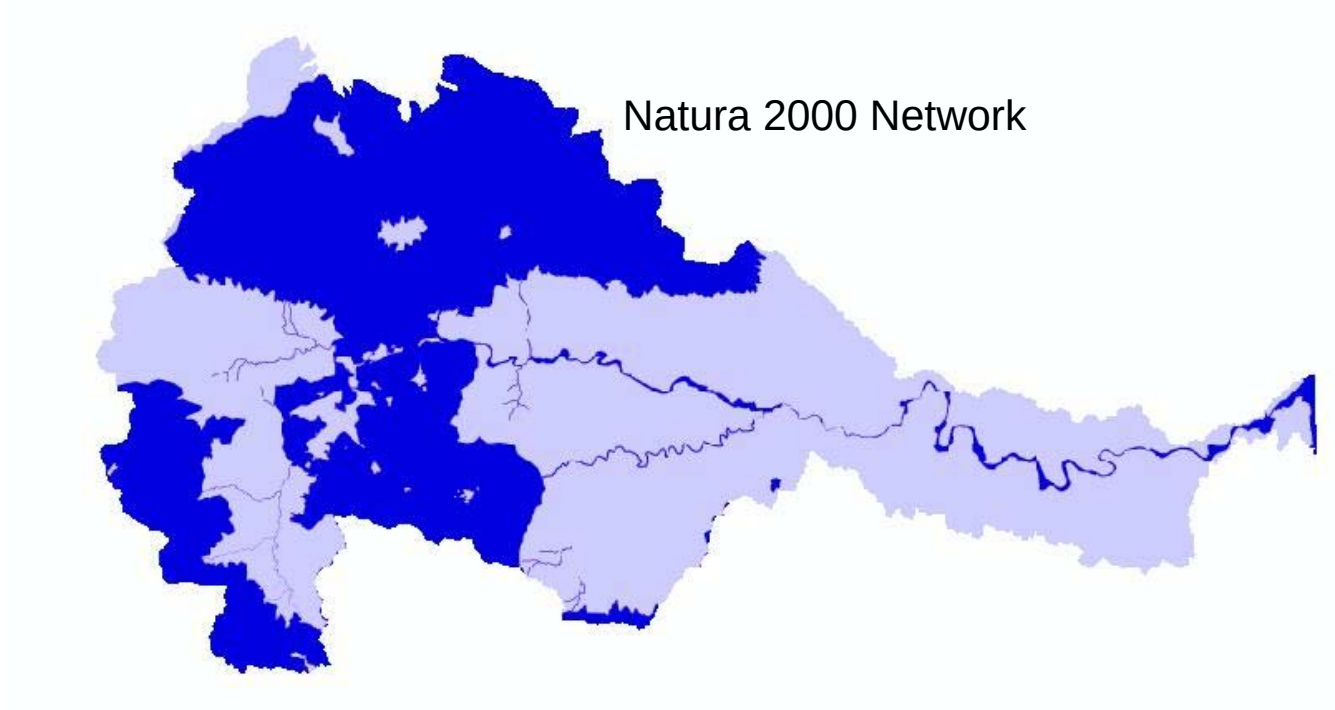




2.1. Building up scenarios – Methodologies

2030 Land use cover

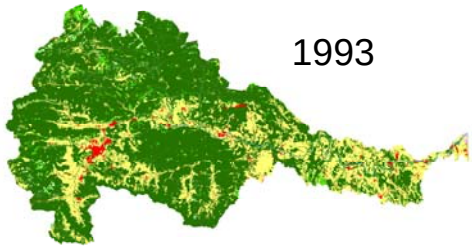
Limitations to changes → Limitation to urbanization in protected areas



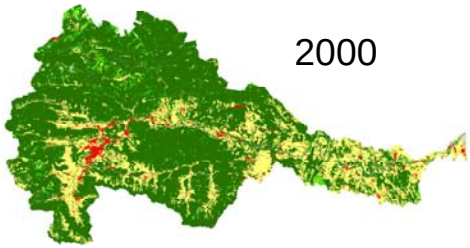
2.1. Building up scenarios – Methodologies

2030 Land use cover

Land cover maps

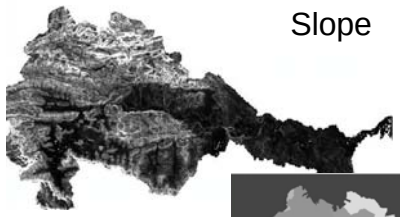


1993

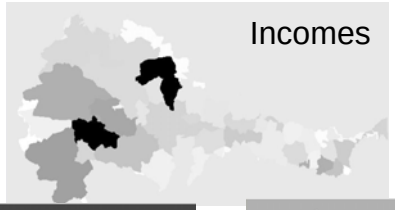


2000

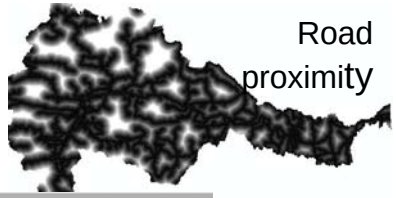
Explanatory variables



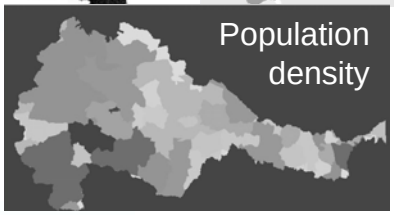
Slope



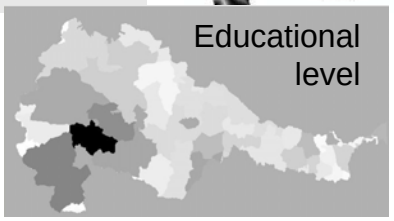
Incomes



Road proximity



Population density



Educational level

Limitations

2.1. Building up scenarios – Methodologies

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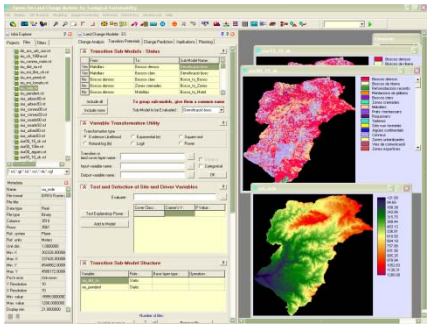
2030 Land use cover

Land cover maps

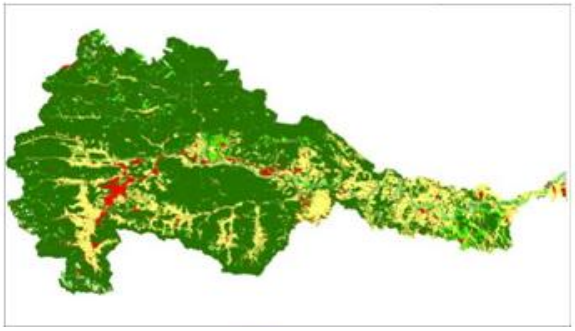
Explanatory variables

Limitations

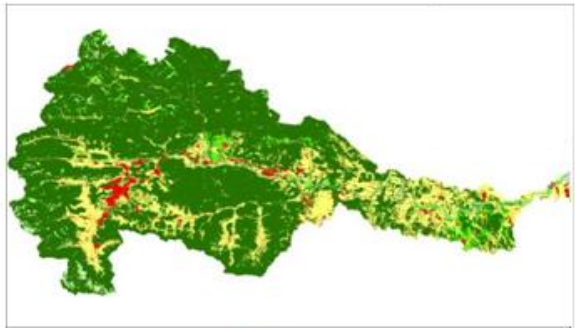
Land Change Modeler (Idrisi)



Trend



Sustainable



2.1. Building up scenarios – Methodologies

2030 Land use cover

Fluvià – Relative changes per land use cover

Land use cover	% change (in surface) 2005-2030 Trend scenario	% change (in surface) 2005-2030 Sustainable scenario
Forest	6%	4%
Shrublands	-23%	-23%
Pastures	-38%	8%
Crops	-12%	-11%
Urban areas	18%	4%

But when comparing changes respect the whole river basin area!

2.1. Building up scenarios – Methodologies

2030 Land use cover

Fluvià – Total changes compared with the whole river basin

Land use cover	% change (in surface) 2005-2030 Trend scenario	% change (in surface) 2005-2030 Sustainable scenario
Forest	4%	3%
Shrublands	-1%	-1%
Pastures	-1%	0%
Crops	-2%	-3%
Urban areas	1%	0%

Changes were not so newsworthy ….

2.1. Building up scenarios – Methodologies

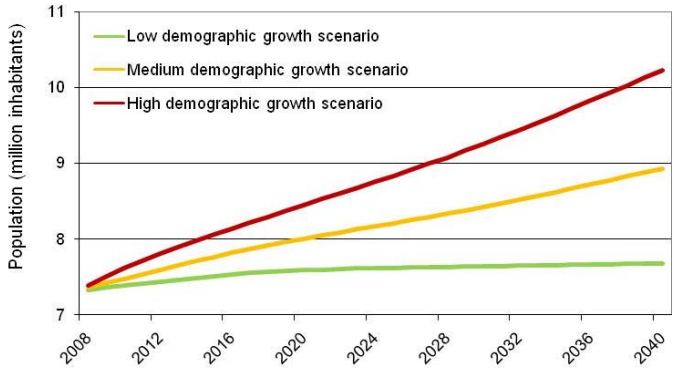
Two required outputs:

- **Land use cover for 2030:** Application of the Land Change Modeller (LCM) Extension of IDRISI
- **Water demands per user sector for 2030**: Numerical approach to estimate future population and water demands

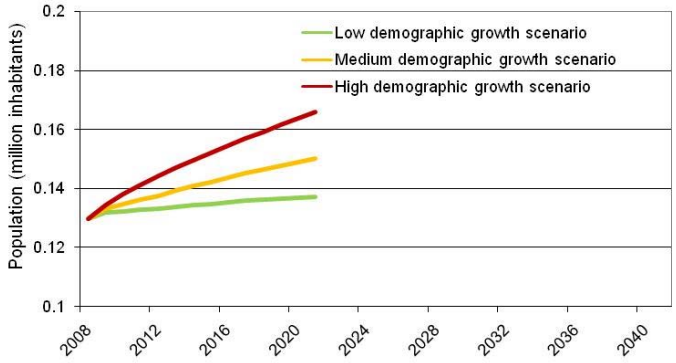
2.1. Building up scenarios – Methodologies

2030 population

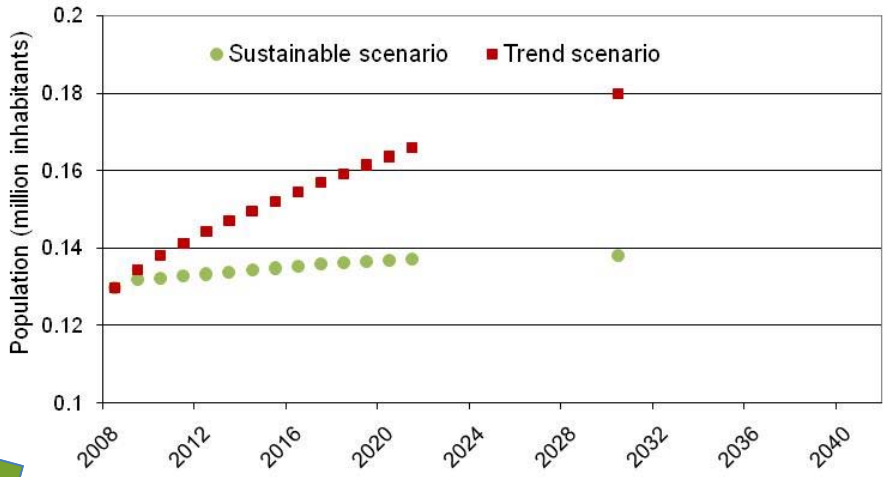
Catalan population



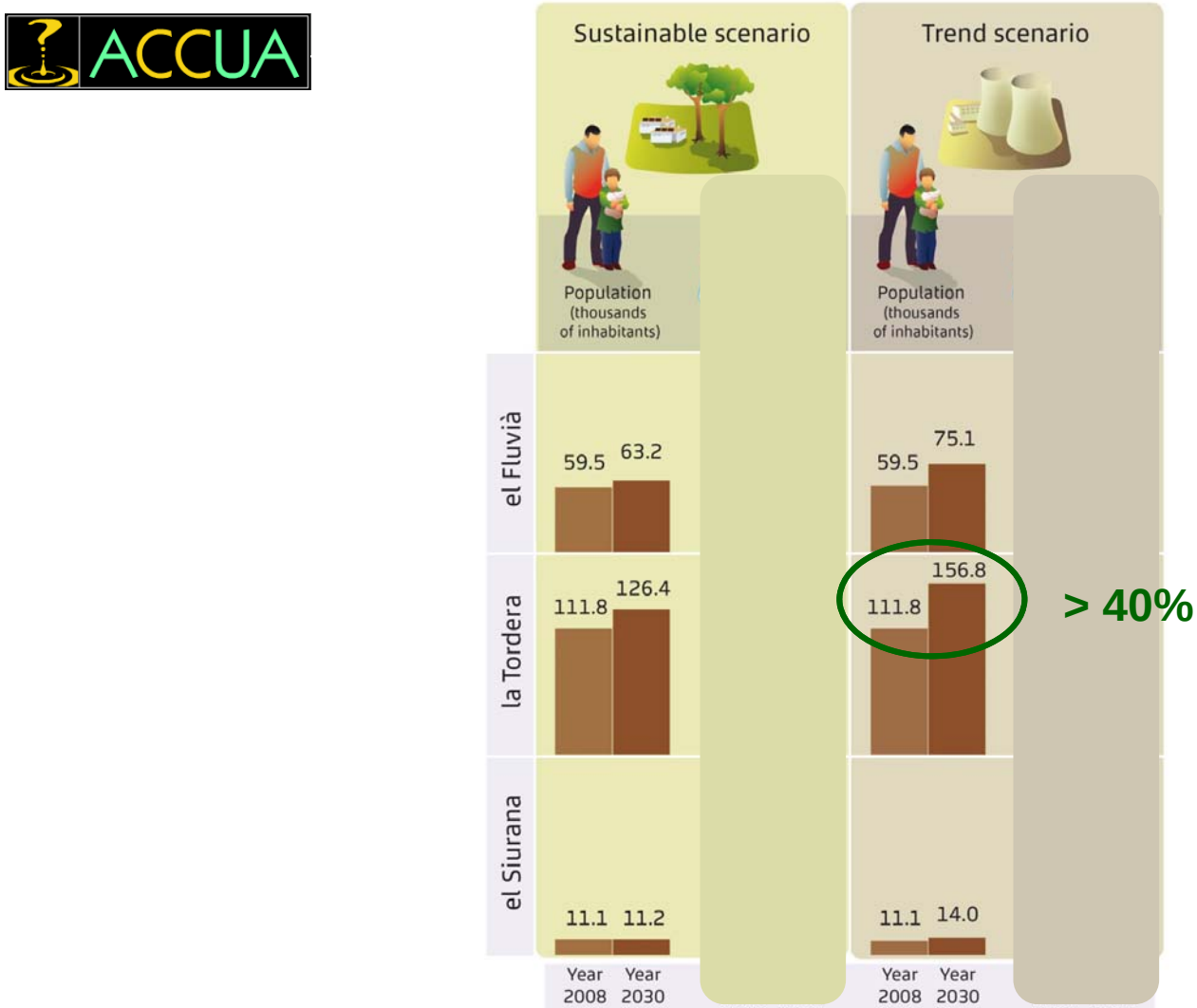
Alt Empordà region



Alt Empordà region



2.1. Building up scenarios – Methodologies



2030 population

> 40%

2.1. Building up scenarios – Methodologies

2030 water demands

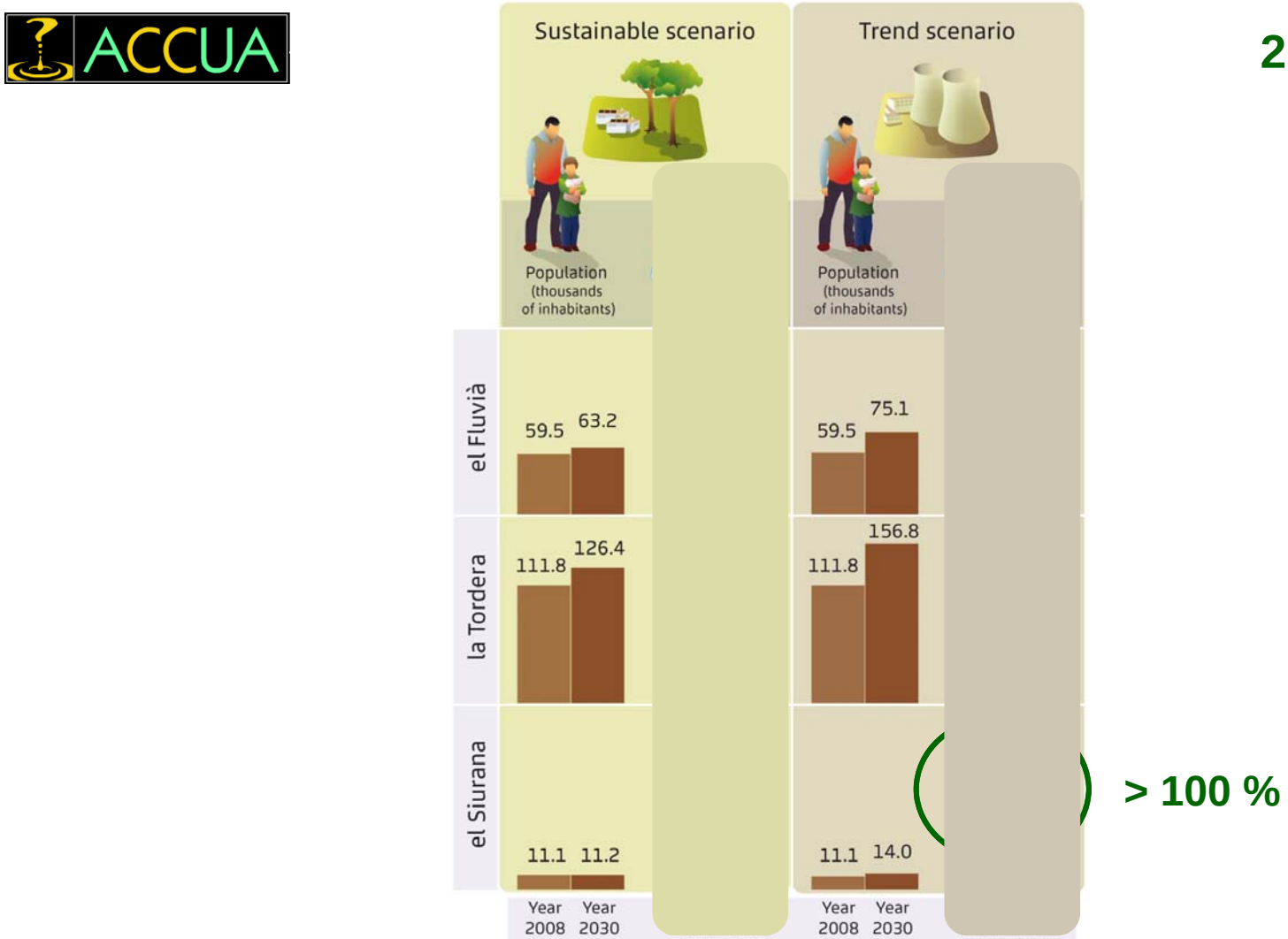
Trend scenario: Maintenance of current water demands:

- Domestic sector: High population growth + current water demands
- Agricultural sector: Irrigation plan + current water demands + CC
- Industrial sector: Current water demands
- Recreation sector: Increase of water demands by sportive areas

Sustainable scenario: Application of a saving scenario based on the hydrological planning

- Domestic sector: Low population growth + high water demand saving
- Agricultural sector: No irrigation plan + water demand saving (4.4%) + CC
- Industrial sector: Water demand saving (3.6%)
- Recreation sector: Current water demands + increase water re-use

2.1. Building up scenarios – Methodologies



2030 water demands

> 100 %

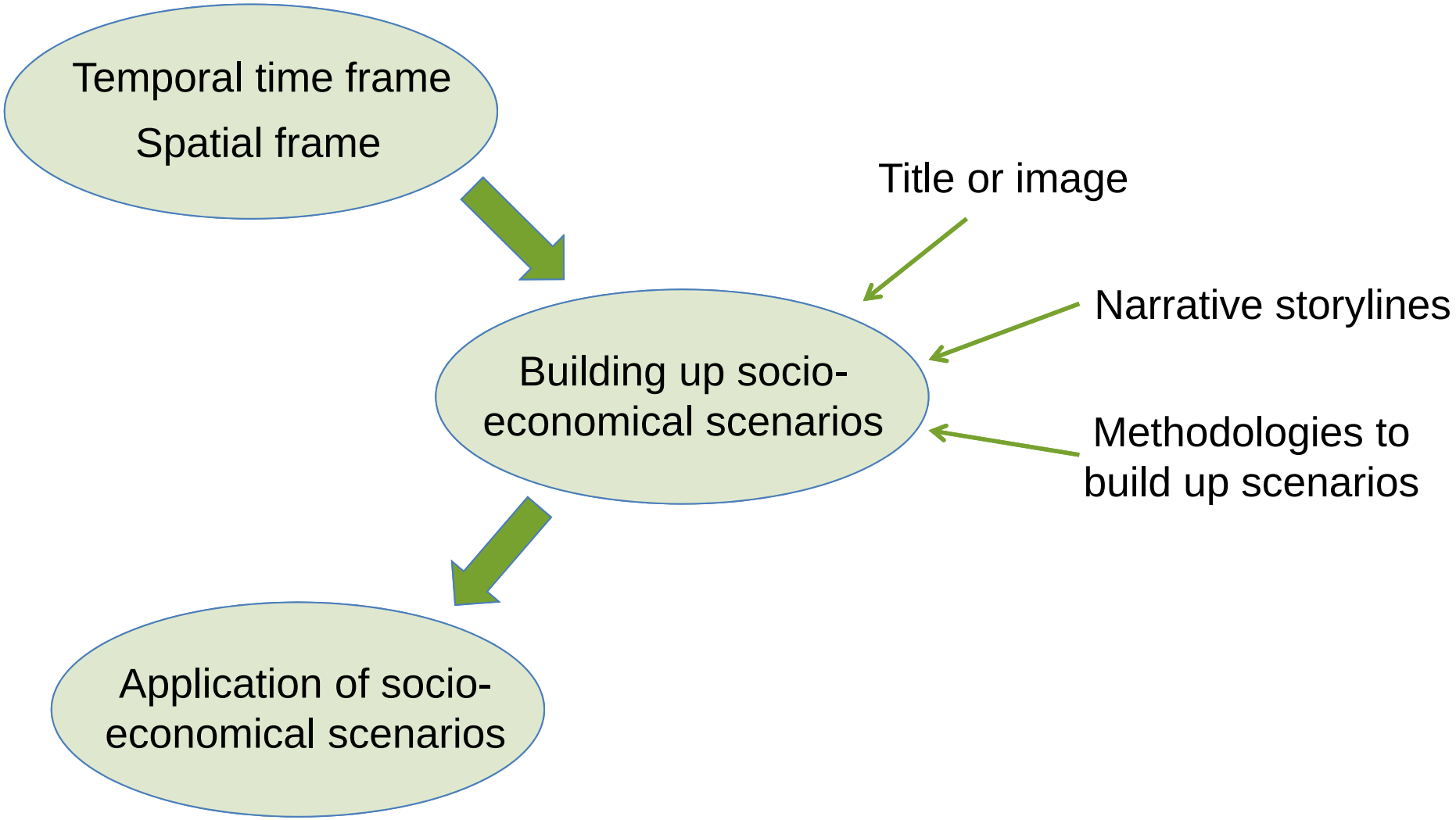
2.1. Building up scenarios – Methodologies

Adapting the Mediterranean to climate change

Two required outputs:

- **Land use cover for 2050** (headwater scenarios)
  - AFOR, MOSAIC: Application of cellular automata models
  - FIREFOR: Application of MEDFIRE model
  - MANAGEFOR: Application of the Catalan biomass planning
- **Water demands for 2050** (medium and low course scenarios)
  - RATUSE: Reduction of water extractions:
    - reduction of domestic water consumption
    - use of regenerated water
    - modernization of the irrigation infrastructures
  - HIGHDEMAND: Increase of water demands
    - higher urban, industrial and agricultural consumption
    - obsolescence of irrigation infrastructures

General approach



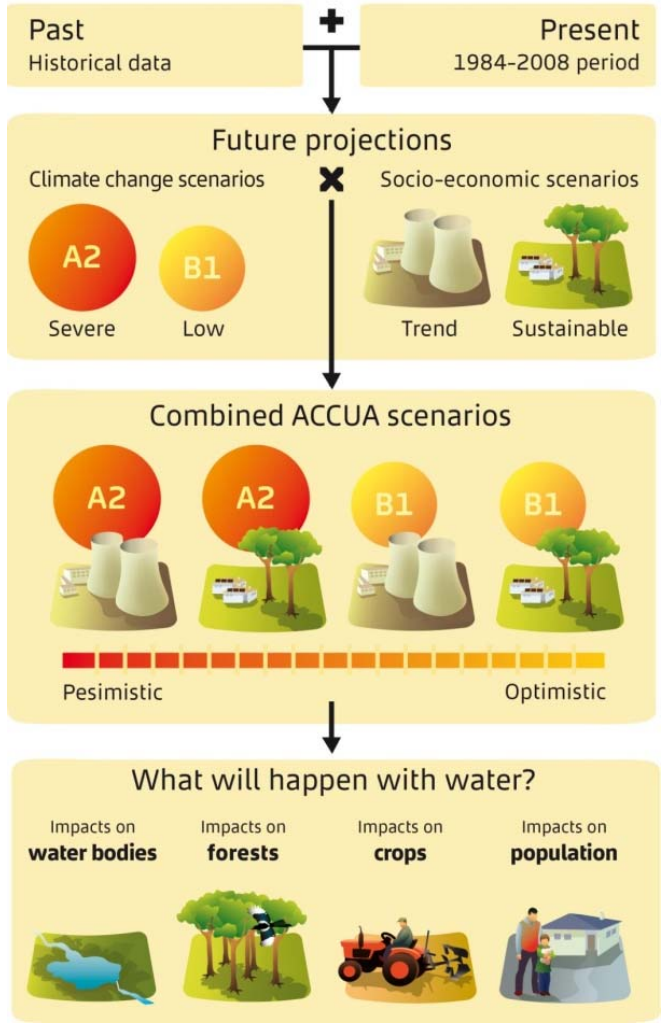
3. Application of socio-economical scenarios

- Socio-economical scenarios as **input** for further analysis, combined with climate change scenarios:
  - effects on hydrology: changes in water availability, dam volumes or ecological streamflow.
  - effects on population: temperature impacts on some comfort indicators such as the number of hot days (Tmax > 30ºC) or the number of tropical nights (Tmin >21 ºC) in most populated areas
  - effects on forests: forest growth, forest health status, fire risk or changes of species.
  - effects on crops: changes on phenology or water demands.

Consider:

➢ Depending on the subsequent analysis, changes may not be so evident if the socio-economical scenarios are not clearly different

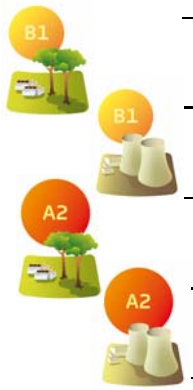
3. Application of socio-economical scenarios



3. Application of socio-economical scenarios

Stream flow changes in 2006-2030

Relative stream flow changes from 2006-2030 respect to 1984-2008 (in %)



Stream flow variation at headwater				Stream flow variation at river mouth			
- 8	- 5	+ 9	%	- 5	- 3	- 4	%
-11	- 5	+11	%	- 5	- 2	- 8	%
-20	-11	-11	%	-13	-15	-25	%
-20	-11	-10	%	-13	-14	-29	%
Fluv	Tord	Siu		Fluv	Tord	Siu	

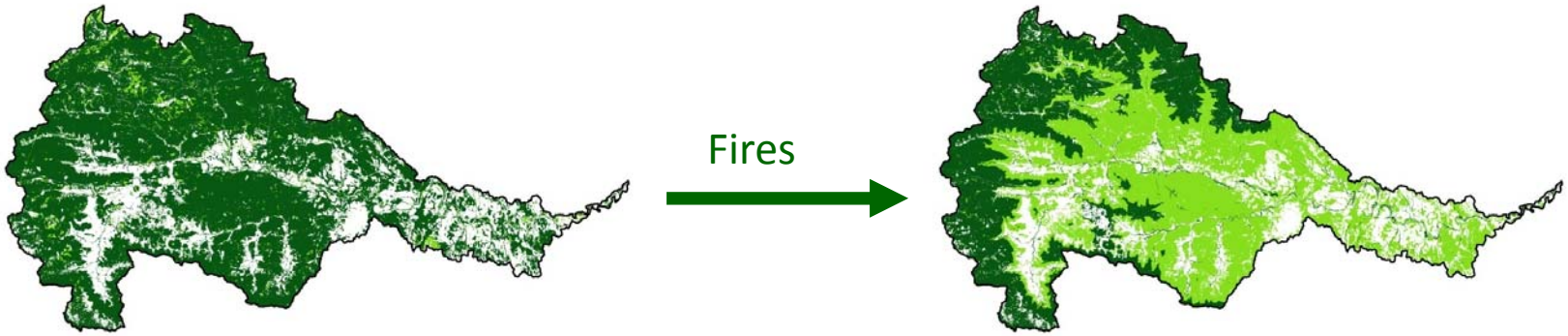
Fluvià and Tordera: socio-economical scenarios **were not relevant** in water balance → Strong effect of **forests** in water balance

Siurana: the development of irrigation plans **amplify** climate change effects

3. Application of socio-economical scenarios

Disturbance effects on water balance: simulation experiment

What will happen if forest surface is reduced to the half by 2030?



Land cover (MCSC, 2005)

- Shrublands
- Forests

Land cover if forest surface is reduced to the half

- Shrublands
- Forests

3. Application of socio-economical scenarios

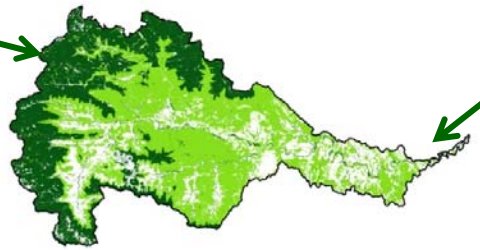
Disturbance effects on water balance: simulation experiment

What will happen if forest surface is reduced to the half by 2030?

A2

+ 7 % increase of stream flow

Fires



+ 9 % increase of stream flow

Maxim stream flow = **117.6** m^3/s

Maxim stream flow = **150.3** m^3/s

- **Increase of the superficial stream flow contributions** along the watershed due to the reduction of actual evapotranspiration and infiltration.
- Increase of the maxim stream flow, increasing the **flood risk**
- Increase of the flow variability, tending to more extreme situations → **Forest as water balance regulators.**

Thank you!

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