

TWP2. TOWARD AN INTEGRATED MODELLING OF THE MEDITERRANEAN SYSTEMS

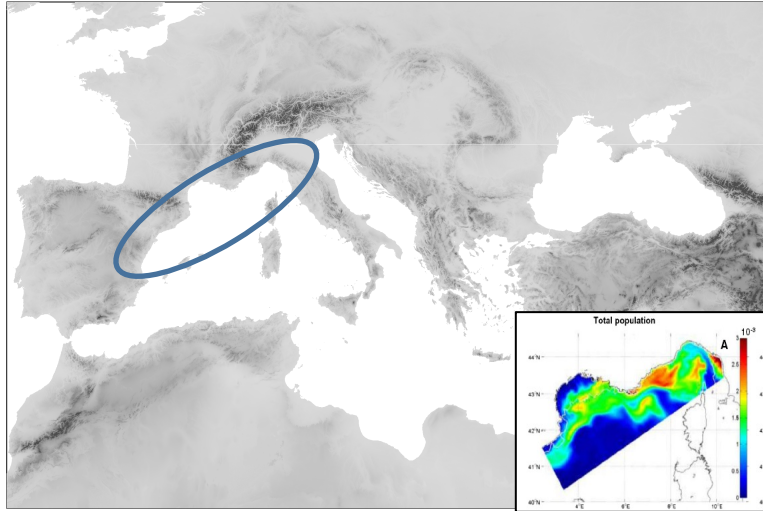
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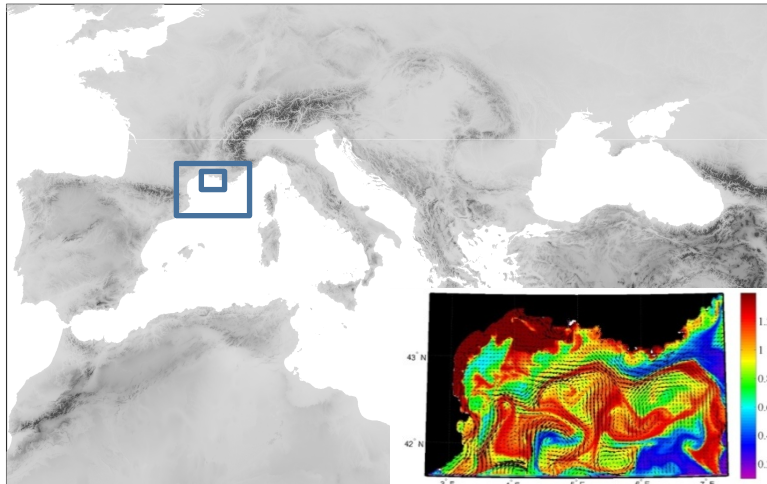
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- Climate change and human activities are likely to strongly affect the Mediterranean socio-ecological systems on a short time scale (< 20 years)
- We need scenarios to support policies of mitigation and adaptation
- We need **up-to-date models in each discipline**, **their integration in a generic Mediterranean vision**, and **their coupling**
- Simulations for the past, the present, and the future:
 - past: backward simulations of the past socio-ecological systems (also a proof of the method)
 - present: sensitivity studies (to different modes of model coupling, to various human forcings, etc)
 - future: climate and socio-economic scenarios

=> a model catalogue to be put on the OT-Med site



total population of copepods



chlorophyll-a surface concentrations

Ocean: circulation, biogeochemical cycles, ecology

MIO

Biogeochemical model Eco3M: Ecological Mechanistic and Modular Modelling

1) Eco3M-S/Symphonie : mesoscale hydrodynamics on nutrients, plankton distributions and cross-to-offshore exchanges.

- coupled with a high trophic level model (OSMOSE) => fishes distribution & stocks
- coupled with zooplankton functioning => carbon fluxes

2) Mars3D-GULI/RHOMA_Eco3M-MASSILIA: impacts of nutrients and organic matter inputs on the functioning of the coastal ecosystems



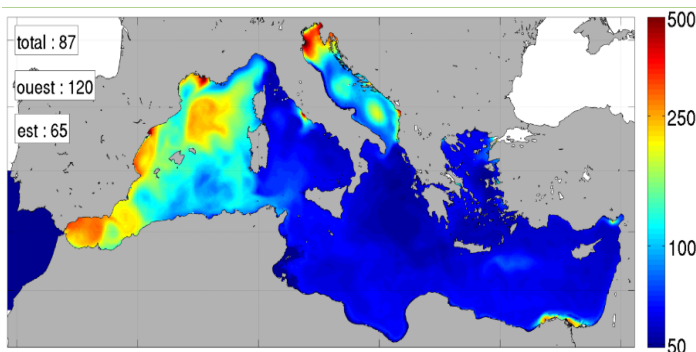
Ocean: circulation, biogeochemical cycles, ecology

MIO

Biogeochemical model Eco3M: Ecological Mechanistic and Modular Modelling

3) Mars3D-MENOR/Eco3M-MED & NEMO-MED12/Eco3M-MED: dynamics of the trophic web & associated biogeochemical fluxes.

Elena Alekseenko: “Modeling the impact of the quantity and quality of nutrient inputs on the structural and functional dynamics of planktonic diversity”.



Winter Gross Primary Production

Perspectives:

To use management-driven main nutrients flows calculated by agro-ecosystem model toward the Mediterranean Sea

Potential linkages with other models: Integrated Assessment Models, Land Use models, ...

Ocean: circulation, biogeochemical cycles, ecology



CEREGE

Coupled oceanic circulation
and biogeochemistry model:
ROMS (Regional Ocean
Modeling System) + PISCES
(oceanic biogeochemistry)

=> coupled models set on the Iberian Margin (tests of oceanic temperature proxies simulations & of foraminifera formulations).

Perspectives:

interactions with a meteorological model (from MIO) to be used as forcing surface boundary conditions.

Terrestrial Ecosystems: Flood / fire risks & vulnerabilities

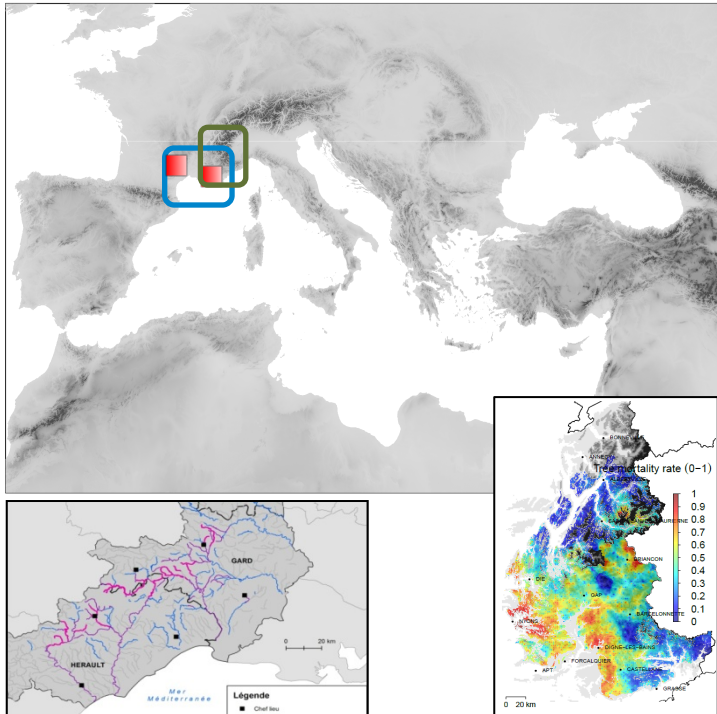
IRSTEA

1) AIGA system: issue real time warning during flash flood events.

2) Macropolis/Micropolis-FIRE

Impacts of wildland urban interface dynamics on change in wildfire risk

3) Ecosystem vulnerability-to-fire: statistical modeling of fire behavior & tree post-fire mortality under severe weather conditions

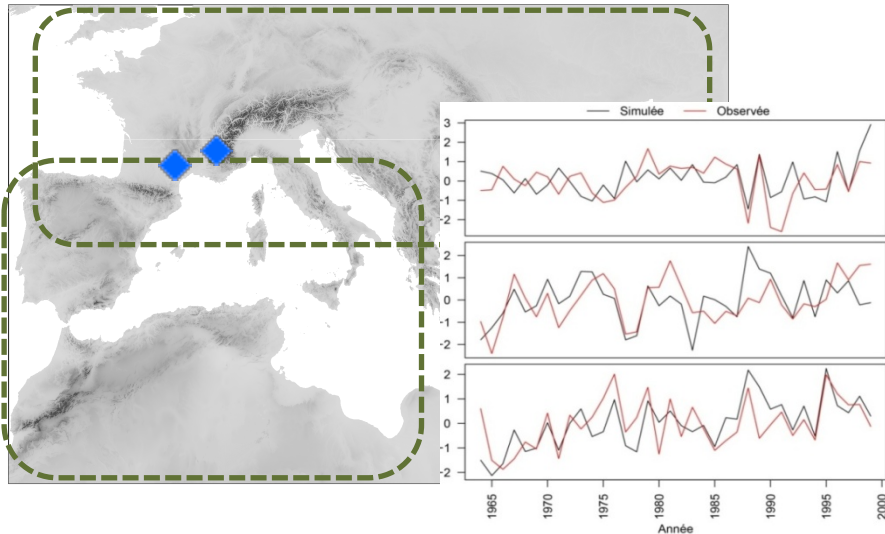


*return-time
river discharges*

*post-fire tree
mortality rate*

Perspectives:

- *climate change scenarios*
- *land use & forest management models*
- *economic damage models*



*tree ring widths, $\delta^{13}\text{C}$ & $\delta^{18}\text{O}$
stable isotope fractionation*

Terrestrial ecosystems: Forests

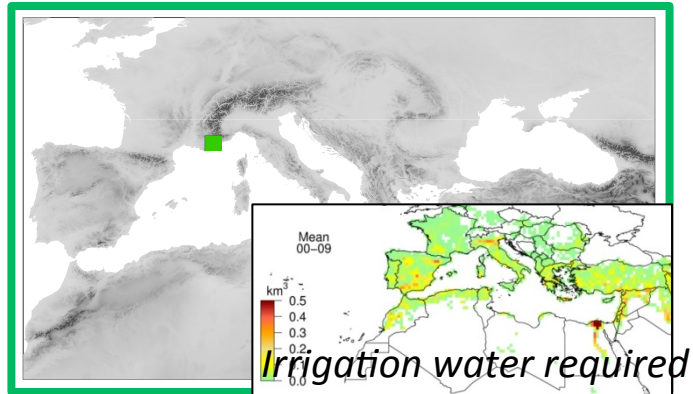
CEREGE

MAIDEN: Process-based stand dendroecological model, global change impacts on forest productivity

- MAIDEN: vulnerability of the Mediterranean forest functional types
Guillermo Gea-Izquierdo : “Assessing vulnerability to global change of Western Mediterranean forests using a multi-proxy mechanistic approach”.
- MAIDENiso (isotope-enabled): forest ecology and paleoclimatology, adaptation to cold environment.

Perspectives:

- *climate change impact on forest productivity & vulnerability in the Western Mediterranean,*
- *data assimilation (Paleomex)*



Terrestrial agro-ecosystems IMBE

agro-ecosystem models LPJmL & LPJ-GUESS:
climate + management impacts on the
functioning of agro-ecosystems (water &
carbon cycles, carbon allocation)

=> simulation of a range of ecosystem services (food, feed, biofuel, water fluxes, C sequestration, etc) & related socio-economic indicators.

- 1) Accounting for farming practices that lead to a better resilience,
- 2) Representing the impact of biodiversity on litter decomposition,
- 3) Assessing future irrigation, [Marianela Fader](#): “Climate change impacts on irrigation water consumption & related energy demand”

Perspectives:

- *implement management-driven main nutrients flows toward the sea,*
- *introduce agriculture-biodiversity relationships,*
- *coupling with agent-based models.*

CEREGE

Simulating past vegetation & water dynamics for the lac Chad,

Camille Contoux: “Modelling paleo-climates with a general circulation model”

=> Integration: climate model + agro-ecosystems model

CEREGE + IMBE

Socio-ecological integration

climate => agro-ecosystems => society

CEREGE + IMBE + GREQAM

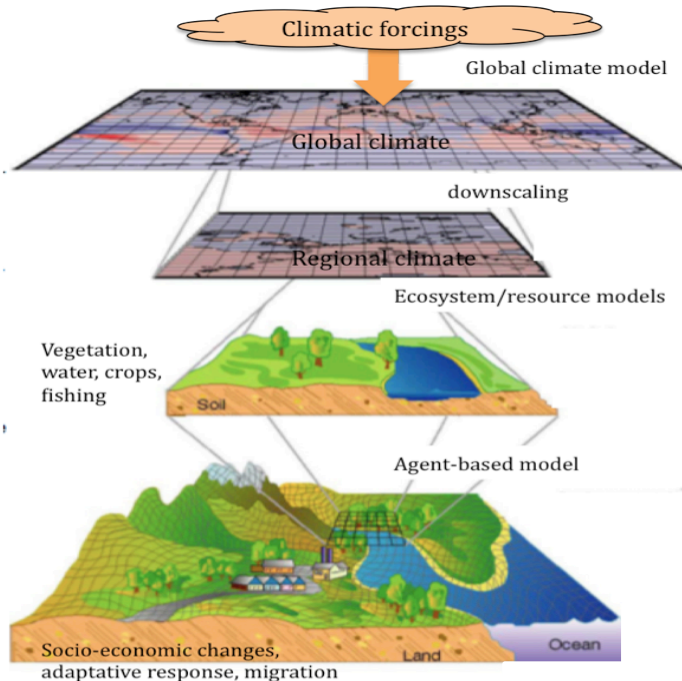
Simulating past crop failures that could have contributed to observed (archeology) societal change during the Holocene.

AMENOPHYS

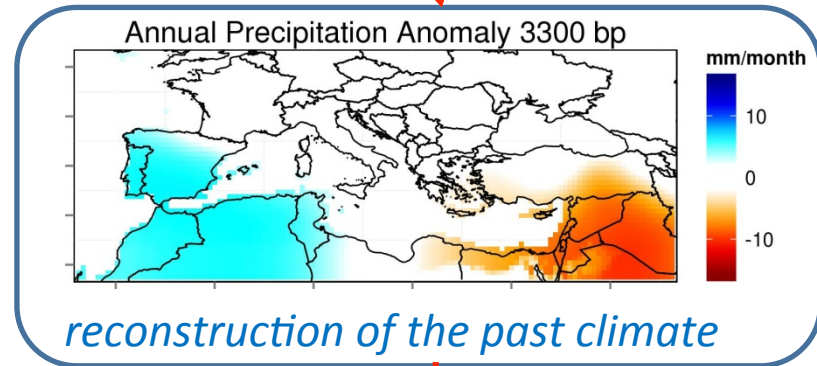
Adaptation of Mediterranean EcoNOMies of the Past to HYdroclimatic changes

3300 BP: drought in the Near East, Mesopotamia => civilization collapse (End of bronze age)

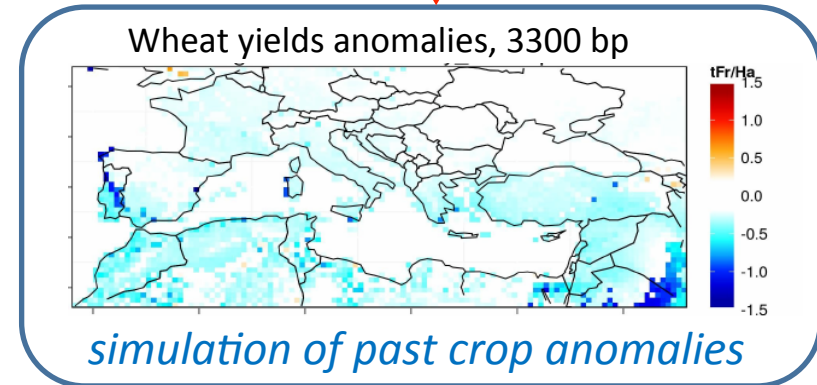
- why? which climate signal?
- which impacts on agriculture ressources?
- which societal response?



pollen data + climate model of intermediate complexity



agro-ecosystem model (crop model)



agent-based model → society response



Human systems (socio-economics)

ECODEV-GREQAM

economic model:

DLPP Determinants of Local
Public Policies

Modelling the determinants of local public policies for farmland preservation & urban expansion.

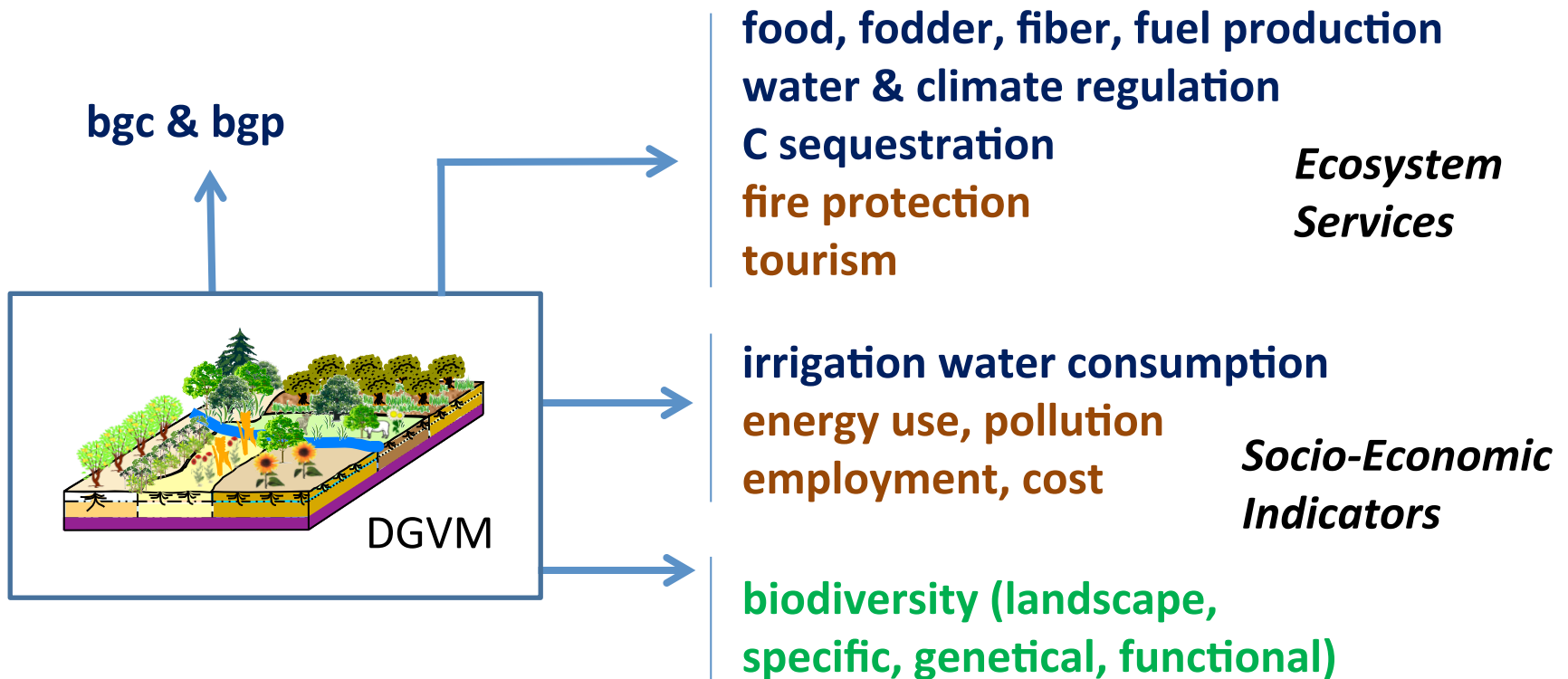
=> exploring the expected effects of socio-demographic determinants, municipal budgetary considerations, the role of the agricultural sector, local political regime and neighbouring relationships.

Starting collaboration with IMBE-LPED, projet SIMBIOSE: designing alternative regional Scenarios for land-use and agricultural Innovative Management and BIOdiverSity consErvation.

Perspective: Running the agro-ecosystem model under these scenarios

Ecosystem services & socio-economic indicators:

- ecosystem services usually simulated by the DGVMs of LUC4C:
food, fodder, fiber, fuel production, water or climate regulation,
C sequestration
- ecosystem services related to DGVMs inputs or variables:
fire protection, tourism, water quality,
biodiversity protection
- socio-economic indicators related to DGVMs inputs or variables:
water consumption, energy use, labor & energy costs, employment



Which scenarios for which future?



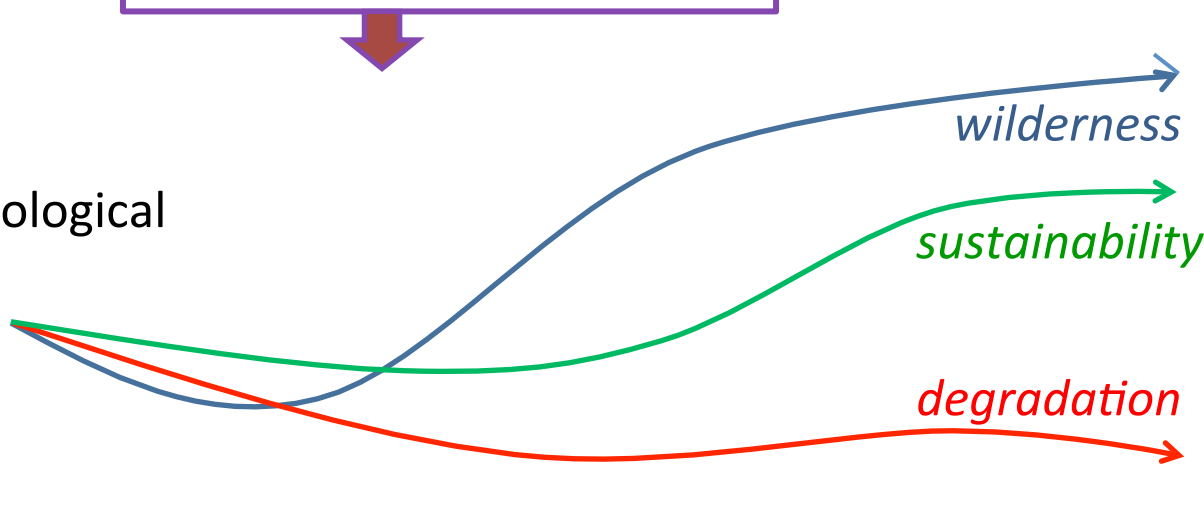
Goal-oriented decision-making

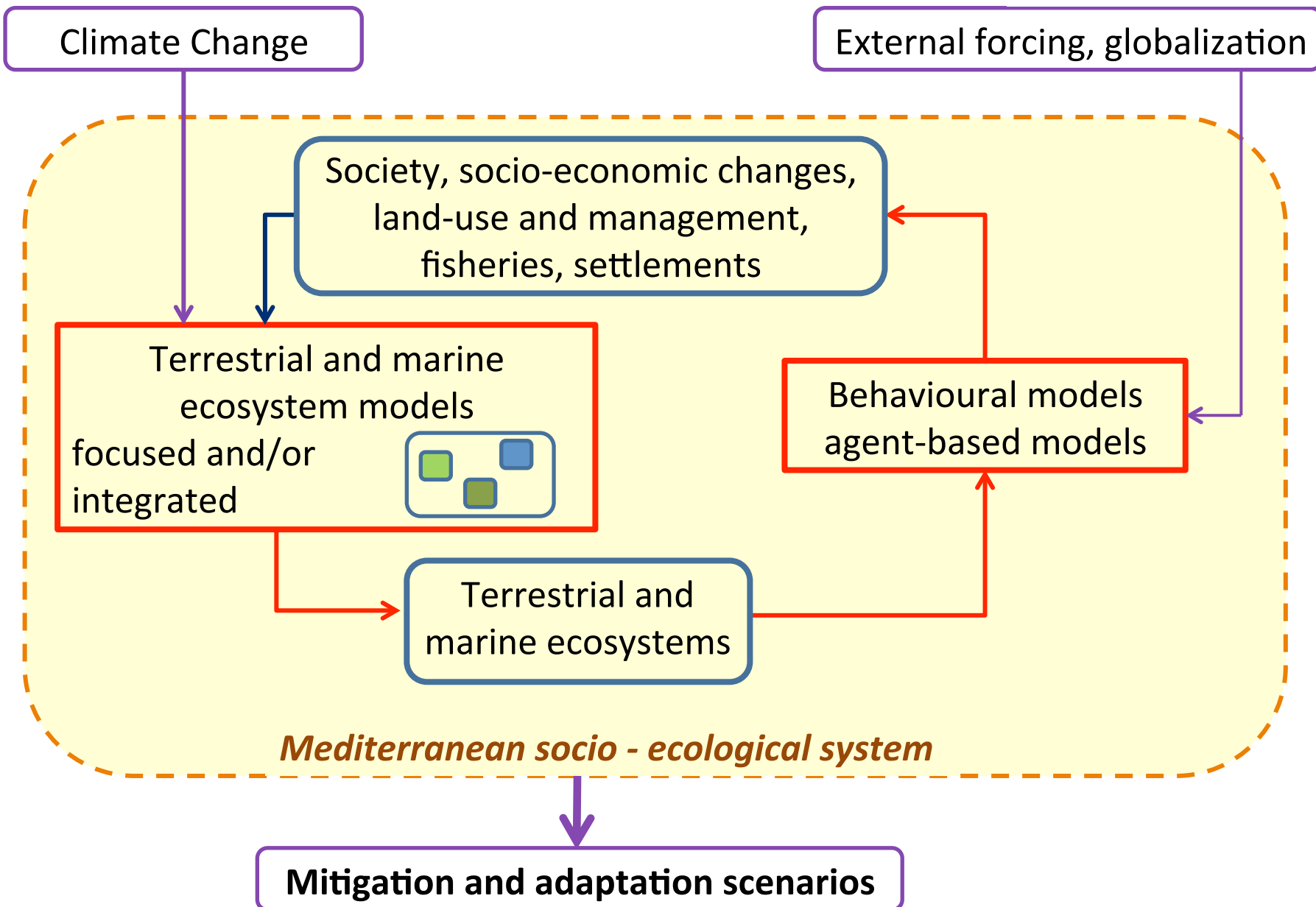
(Image © Sytse Wieringa and Paul Verschure, Synthetic Perceptive, Emotive and Cognitive Systems group (SPECS), Universitat Pompeu Fabra; <http://specs.upf.edu>.)

climate & human forcing

ecosystem services &
socio-economic indicators

socio-ecological
systems





- Design the necessary exchanges of information between models to allow their integration
- Propose adaptation of models of individual and collective human behaviour, and their implementation within larger models (e.g. agent-based models) in which they will interact with ecosystem dynamics.
- Simulate the evolution of the Mediterranean system in the next decades, based on recent IPCC climate scenarios
- Identify key ecosystem functions and human activities that are potentially affected by these changes
- Develop indicators and methods of valuation of ecosystem services and socio-economic impacts based on the analysis of trade-offs and synergies
- Provide as an output scenarios of mitigation and adaptation