Economically and environmentally resilient farming systems in the Mediterranean Basin. A case study of the importance of pollination services in French arable crop farms

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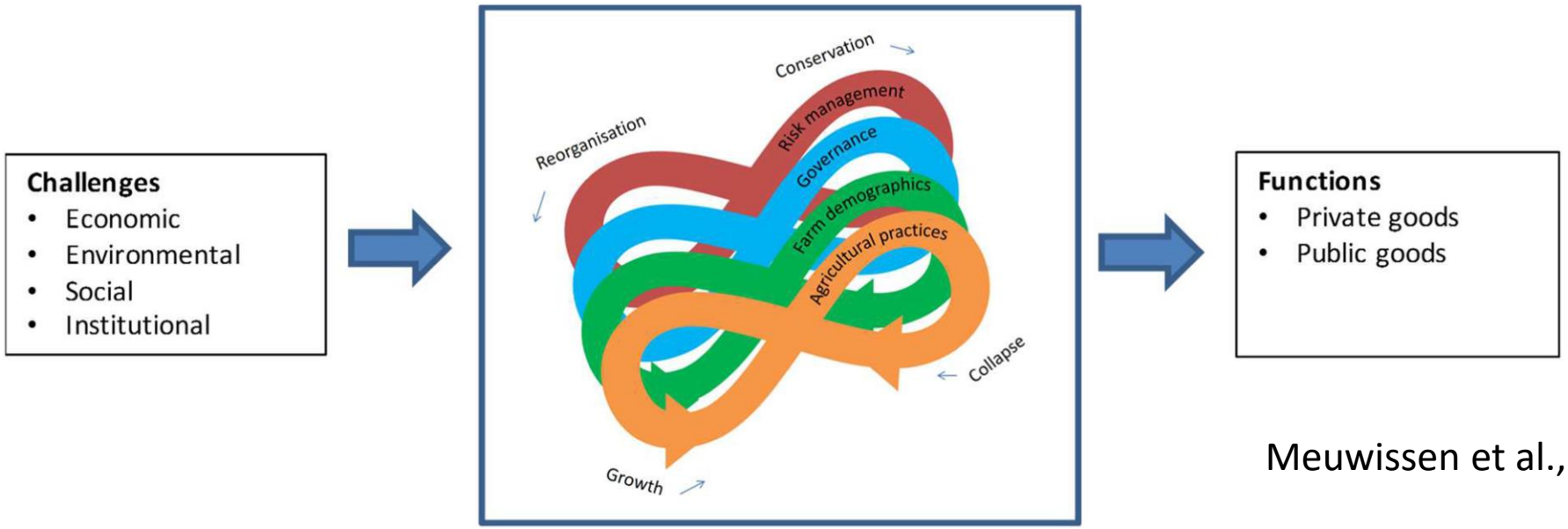
Economically and environmentally resilient farming systems

Definition: We define resilience of a farming system as its ability to ensure the provision of the system functions in the face of increasingly complex and accumulating economic, social, environmental and institutional shocks and stresses, through capacities of robustness, adaptability and transformability.

- Socio-economic shocks ➔ e.g. market shocks, price volatility, etc…
- Environmental shocks ➔ e.g. Bad weather conditions, diseases, climate change, degradation of natural resources, etc….
- Institutional shocks ➔ e.g. public policy changes, cultural changes, behavioural changes, etc…

But what are these system functions ??????



Meuwissen et al., 2019

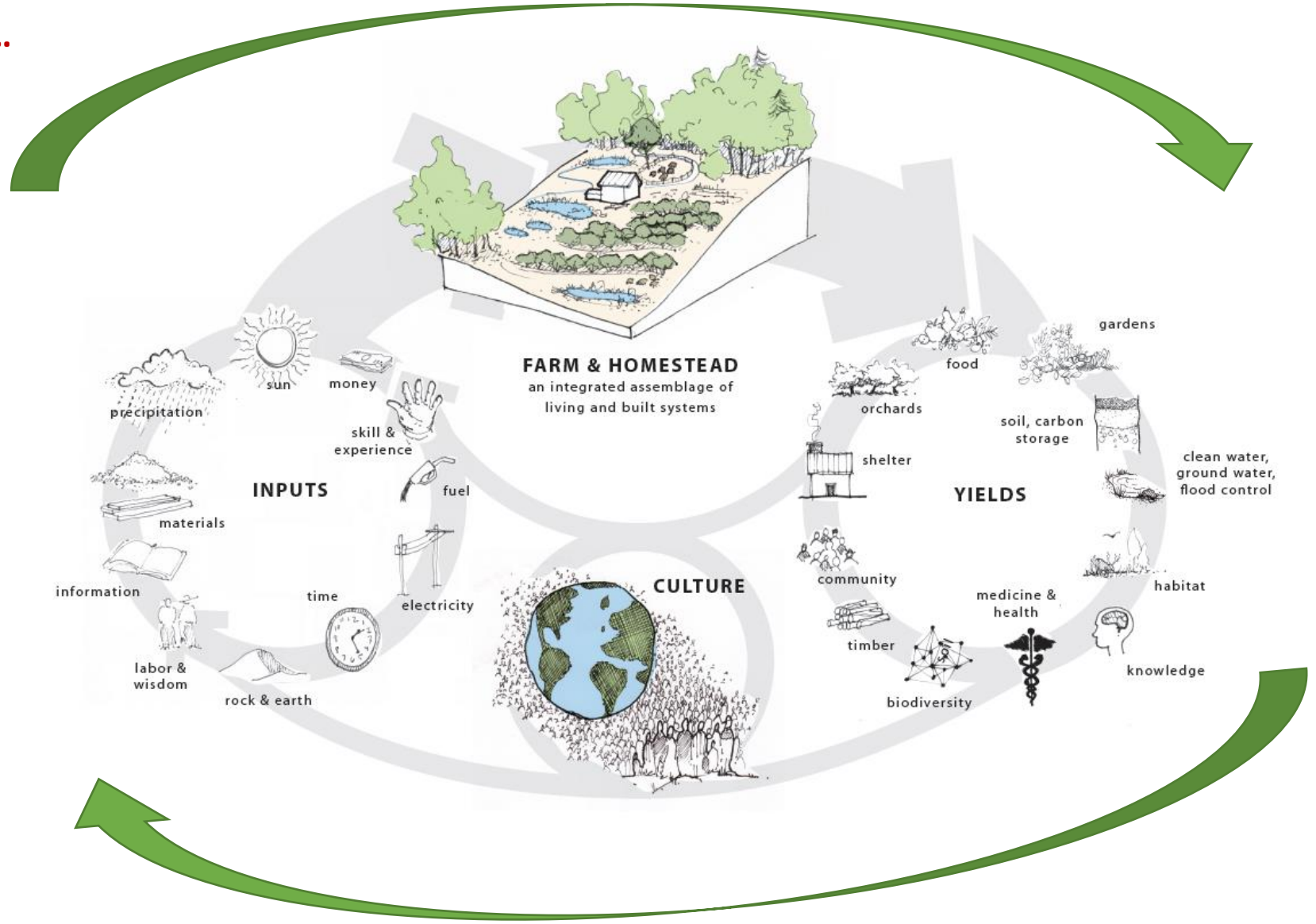
Economically and environmentally resilient farming systems

Private goods	Public goods
Deliver healthy and affordable food products	**Maintain natural resources in good condition**
Deliver other bio-based resources for the processing sector	**Protect biodiversity of habitats, genes and species**
Ensure a reasonable livelihood for people involved in farming	**Ensure that rural areas are attractive places for residence and tourism with a balanced social structure**
Improve quality of life in farming areas by providing employment and decent working conditions	**Ensure animal health and welfare**

Meuwissen et al., 2019

Economically and environmentally resilient farming systems

However…



Ecological functions

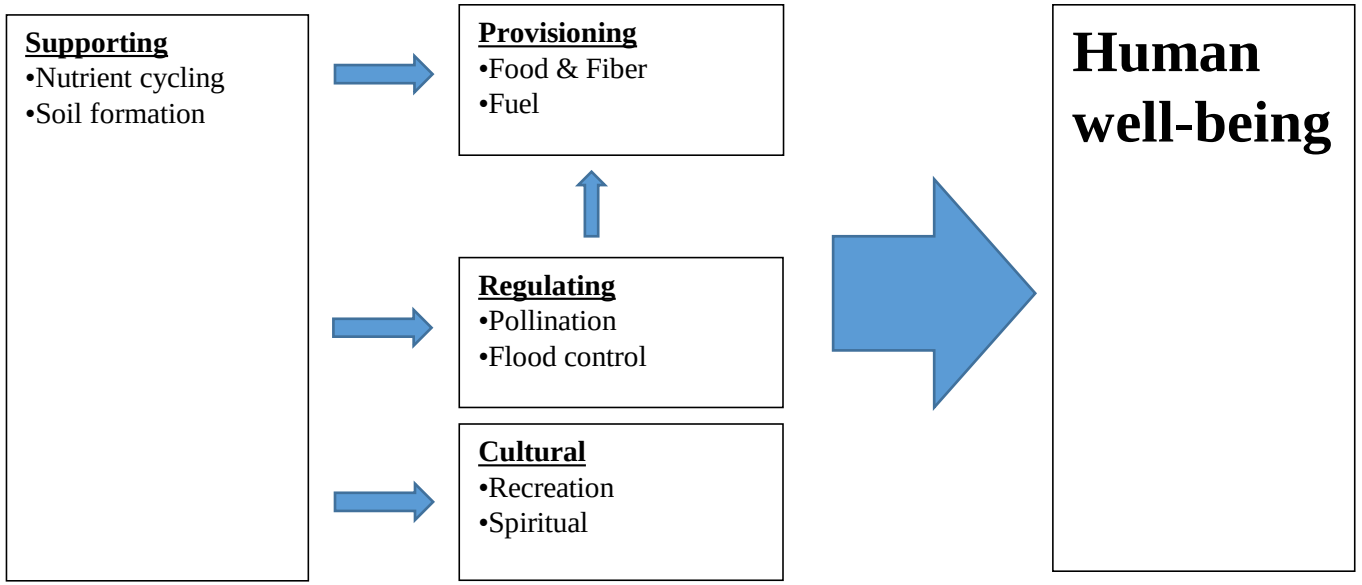
Ecosystem Services

Meuwissen et al., 2019

Ecosystem Services (ES) and humans' welfare

ES consist of flows of energy, materials and information from natural capital stocks (e.g. soils, forests, water bodies) which could be combined with human capital and manufactured services in order to produce human welfare (Costanza et al., 1997)

Classification of ecosystem services from the Millennium Ecosystem Assessment

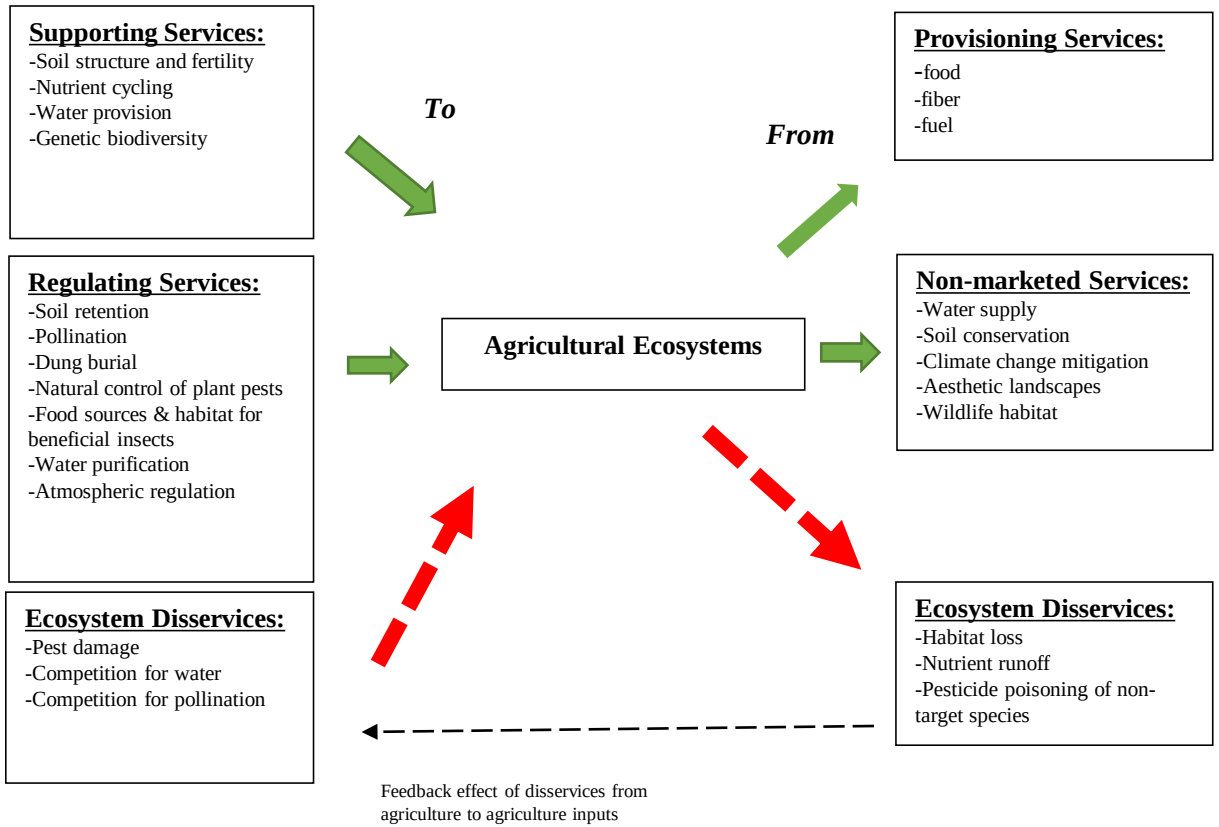


US$16–54 trillion per year

US$18 trillion per year to global economy

Source: Zhang et al. 2007

Ecosystem Services (ES) and agriculture



Source: Zhang et al. 2007

The Mediterranean
a climate change hotspot where vulnerabilities are exacerbated

SoED 2020
State of the Environment and Development in the Mediterranean

Already
0.4°C
increase in seawater temperature
(up to +3.5°C by 2100)

+1.54°C
increase in air temperature: above the global average
(projection in 2040: +2.2°C versus +1.5°C global level)

Low-lying coastal cultural heritage sites are threatened by flooding and erosion

A decrease of
-0.1
in the pH of the ocean since the pre-industrial period, and a forecast of -0.4 by 2100

Warming
20%
faster than global average

-30%
of rainfall in spring/summer by 2080 and +10/20% of heavy rainfall events outside of summer

Sea level rise

between 0.43 and 2.5 m by 2100, depending on scenarios and projections. Increased risk for the 20 million people living below 5m of current sea level

Increased fire risk through a longer fire season, increasing heatwaves and drought

Consequences

- ⊕ heat waves
- ⊕ coastal erosion
- ⊕ fires
- ⊕ invasive species
- ⊕ acidification of the sea
- ⊕ floods
- ⊖ modification of migrations and risk of extinction of certain species
- ⊖ quality aquaculture fishing
- ⊖ agriculture production

Plan Bleu

#SustainableMED

To consult the full report on the State of the Environment and Development in the Mediterranean and its information sources : www.planbleu.org/soed

The Mediterranean a biodiversity hotspot

SoED 2020
State of the Environment and Development in the Mediterranean

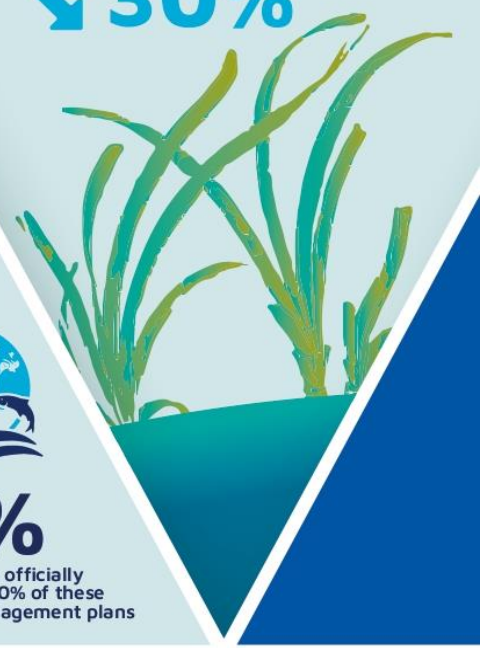
Rich biodiversity under threat
The Mediterranean hosts up to

18%
of the marine species known in the world and 17,000 marine species in just 0.3% of the ocean volume.

Highest rate of endemism in the world: 20-30% of marine species are endemic

The emblematic Posidonia oceanica has experienced a 30% decline over a period of 50 years and its functional extinction is likely by 2100 (no-action scenario)

30%



At least **78** marine species and **168** coastal endangered species

41%
decrease in marine predators (including mammals)

Only **9%**
of the marine area is officially protected and only 10% of these sites implement management plans

1,000
non-indigenous marine species in the Mediterranean, 10% of which are invasive

48%
of wetland habitats have disappeared since 1970

78%
of assessed fish stocks are overexploited

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Loss of biodiversity

means loss of services rendered by ecosystems: protection agains erosion,water purification, flood and drought mitigation, food supply, pollination, carbon storage, cultural and recreational services,...

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Environmental degradation, a risk for human health

SoED 2020

State of the Environment and Development in the Mediterranean

Obesity

Gradual abandonment of the Mediterranean diet:> 20% obesity in all countries (up to> 30%)

Air Pollution

Main environmental health burden with 228,000 deaths

30%

of the population live in water-scarce countries. 220 million people suffer from water scarcity, 26 million do not have access to safely-managed drinking water services, 160 million people do not have access to safe sanitation.

Climate change

increased risks to human health: heat waves and extreme events (droughts, storms and floods), potential for increased transmission of vector-borne, water and food-borne diseases

Chemical products

with synergistic effects are increasingly present in the environment (pesticides and fertilizers, pharmaceutical and cosmetic products, flame retardants, additives for plastics, phytoestrogens, etc.) and their human health effects are largely unknown.

Good news

Improvement in the quality of bathing water: 90% qualified "good" or even "excellent"

Waste

Exposure to managed and unmanaged waste streams can impact human health: cancers, birth defects, miscarriages and premature deliveries, behavioral disorders, ...

Natural hazards

(volcanic and seismic events that can cause tsunamis) and risks related to emergencies and crises caused by humans (conflicts, wars, civil unrest, chemical or radiological incidents) that can impact the quality of the environment and human health.

500 000

deaths per year

in Med countries, attributable to modifiable environmental factors = 15% of deaths. Rate 2 to 3 times higher in the SEMCs and the Balkans than in the EU countries.

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#SustainableMED

To consult the full report on the state of the environment and development in the Mediterranean, and its sources of information : www.planbleu.org/soed

The ecosystem service of bees

Pollination services

Services to agriculture (Williams et al., 1994; Klein et al., 2007; Gallai et al., 2009)

- 75% of global crops used for food production (Klein et al., 2007);
- $127–$152 billion to the global economic welfare (Bauer & Wing, 2016).

Supply

Maintenance of wild flora
(Ashman et al., 2004; Aguilar et al., 2006)

- 80% of wild plants (Ollerton et al., 2011).

Managed bees

Wild bees

Positive externality from local beekeepers (Carreck et al., 1997).

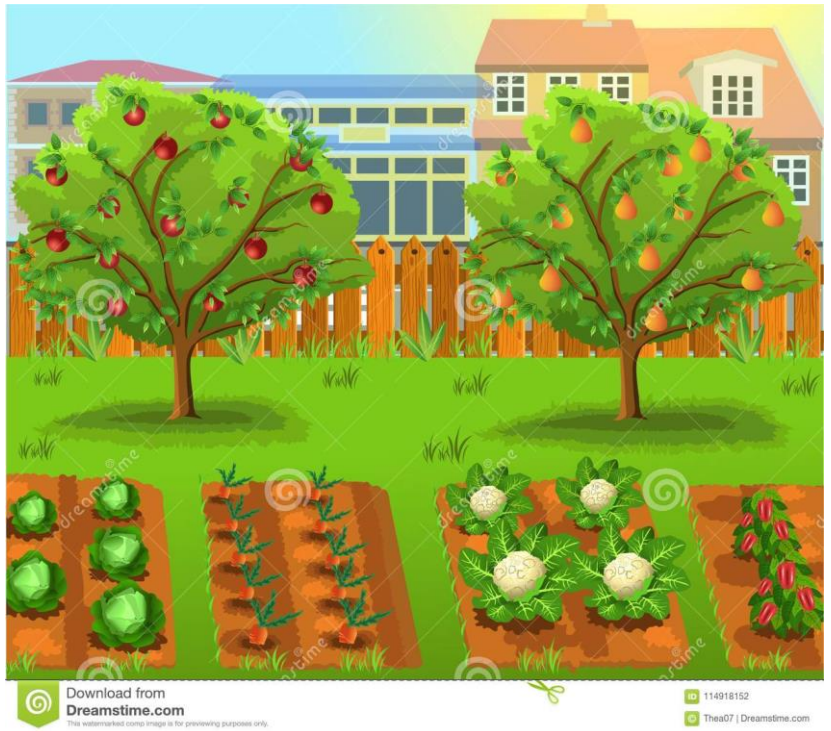
Rented/bought by farmers (Allsopp et al., 2008)

Free from nature

The ecosystem service of bees

Positive externality

Managed bees



Negative externality

Positive externality

Wild bees

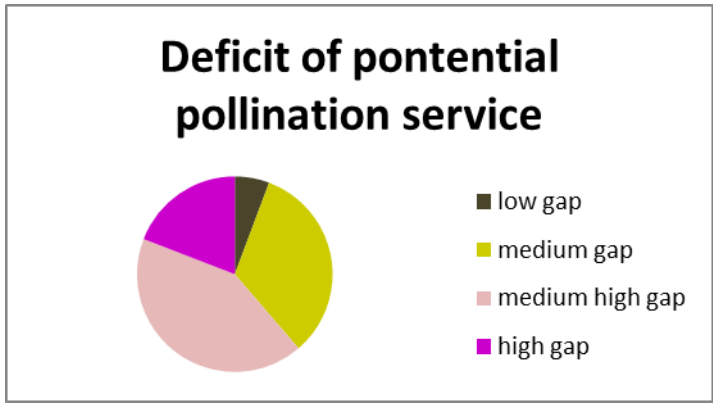
Negative externality

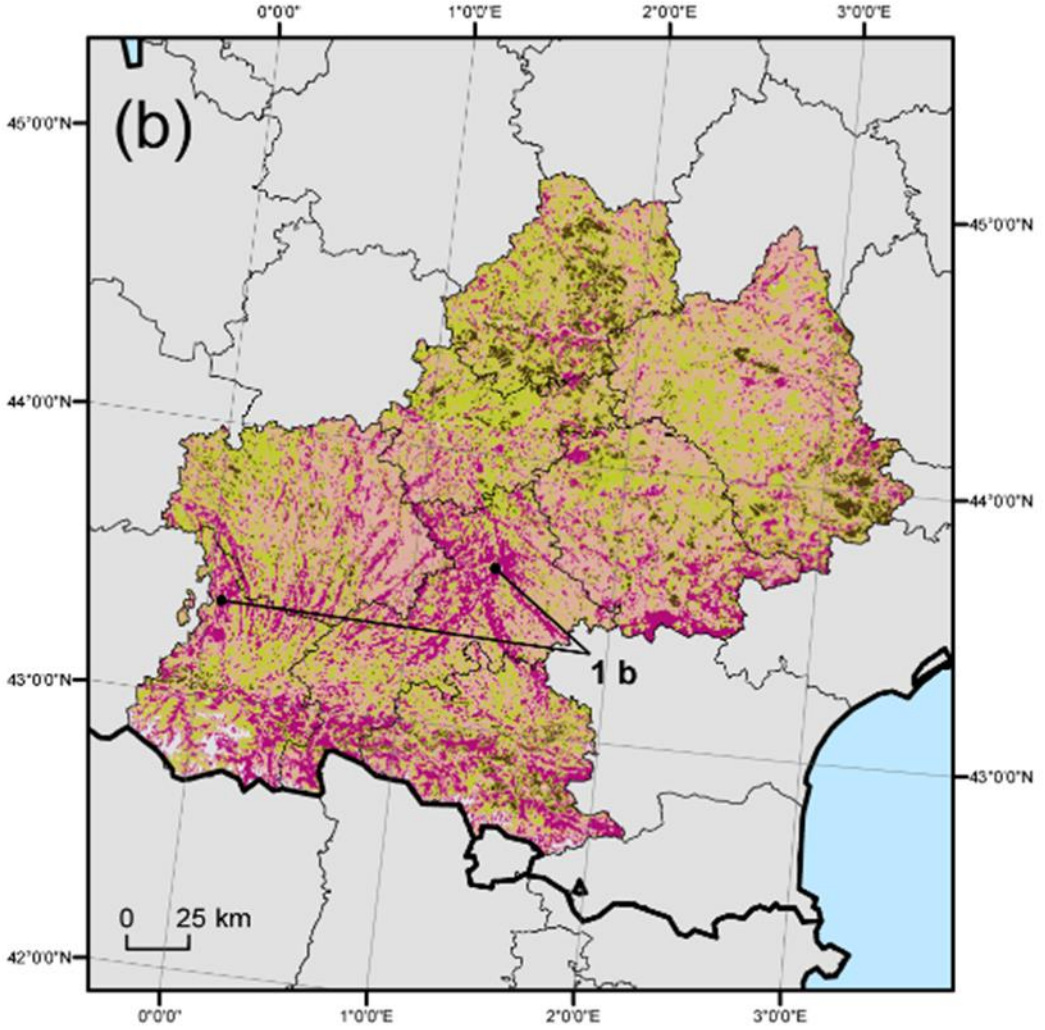
The actual situation in Europe

- Between 1985 and 2005 the 20% of European managed bees colonies has been extinct (Potts et al., 2010a)
- The managed bees mortality in France in 2017 was 60% (Franceagrimer, 2017)
- 5 wild bees species have been extinct from Europe (Goulson et al., 2015)
- Deficit on the provision of managed pollination services across Europe (Breeze et al., 2014)

The situation in France

- **Occitanie region:**



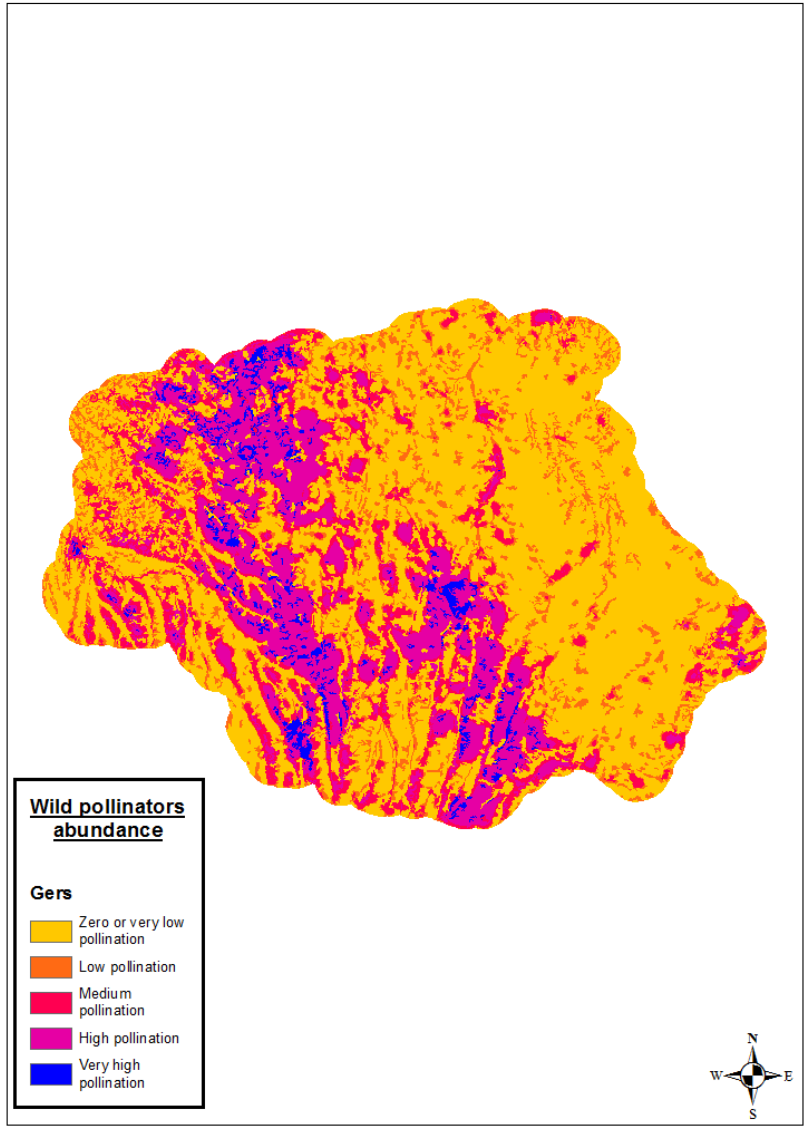


Midi-Pyrénées region in 2014

The situation in France

- **Occitanie region:**

  - **Deficit of wild pollination services**



A case study of the importance of pollination services in French arable crop farms

- Occitanie region:
  - ✓ Establishment of a pollination services market
  - ✓Prices between €50 and €120 per hive
  - ✓Average use 4 hives per ha

} Higher production costs

- Mainly cereals and Oilseeds

- High use of pesticides

- Objective: Creating resilient farming systems by promoting pollinators' friendlier practices through public policy incentives.

The Case Study

Farm-type 1

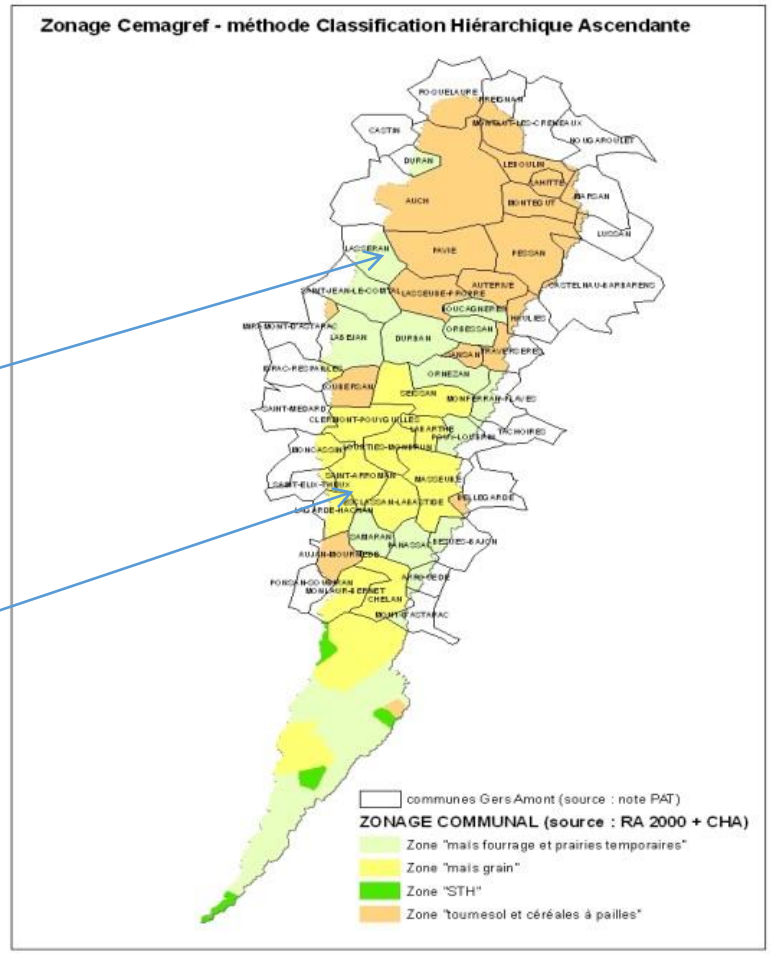
Dry cereals/sunflower

- High labor availabilities
- High initial level of wild pollinators

Farm-type 2

Maize/maize

- Low labor availabilities
- Low initial level of wild pollinators



Crops

Durum-wheat, soft-wheat, barley, maize, oilseed-rape, sunflower and soya.

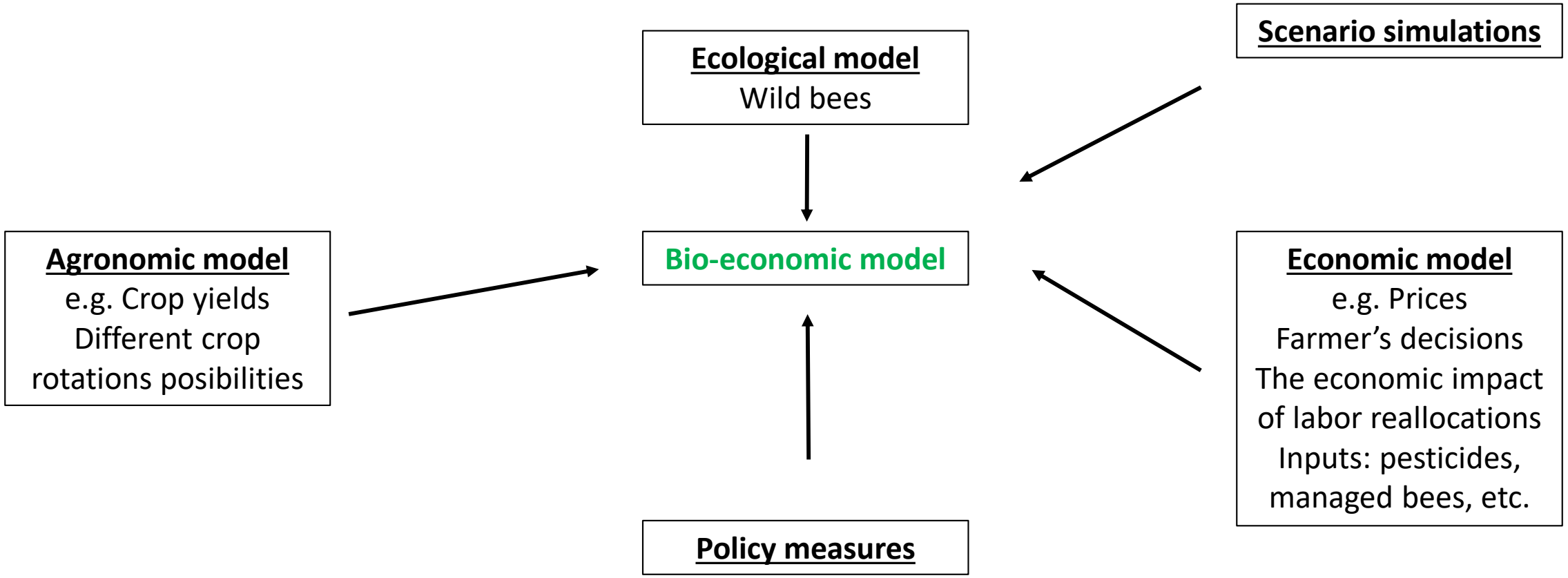
*Ridier et al., 2013

Scenarios and practices

Scenarios	-50% of pests, AES *(Ecophyto)*	-100% of pests, Penalty *(EU No 485/2013)*	-100% of pests, AES
Baseline scenario			
Scenario 1	√		
Scenario 2		√	
Scenario 3			√

- Pesticides => Insecticides and herbicides;
- Novel practices => Replace pesticides' reduction with three operations: field preparation, tillage, and monitoring; => managed bees↓ => labor ↑
- Including different levels of policy incentives and regulations reflecting the society's environmental concerns

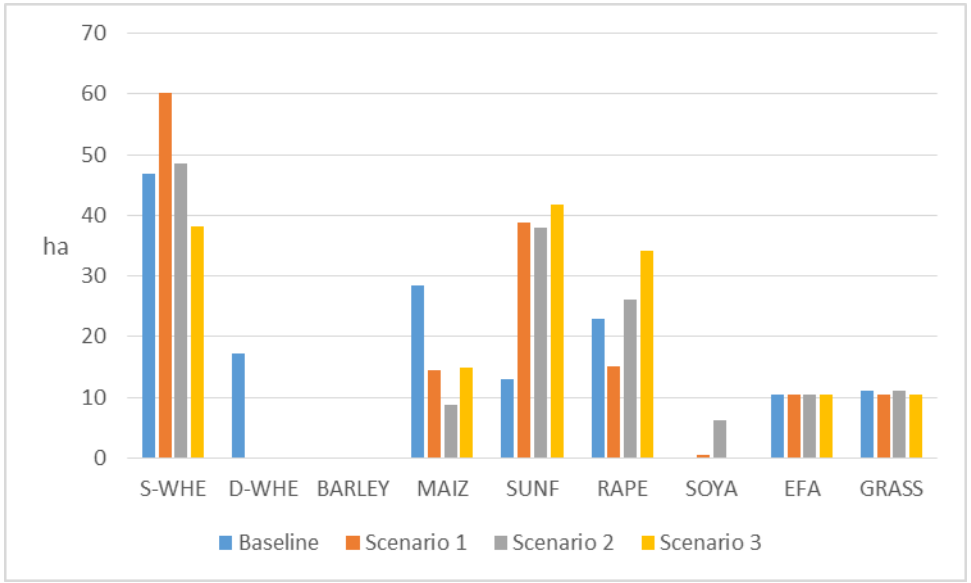
Methodology



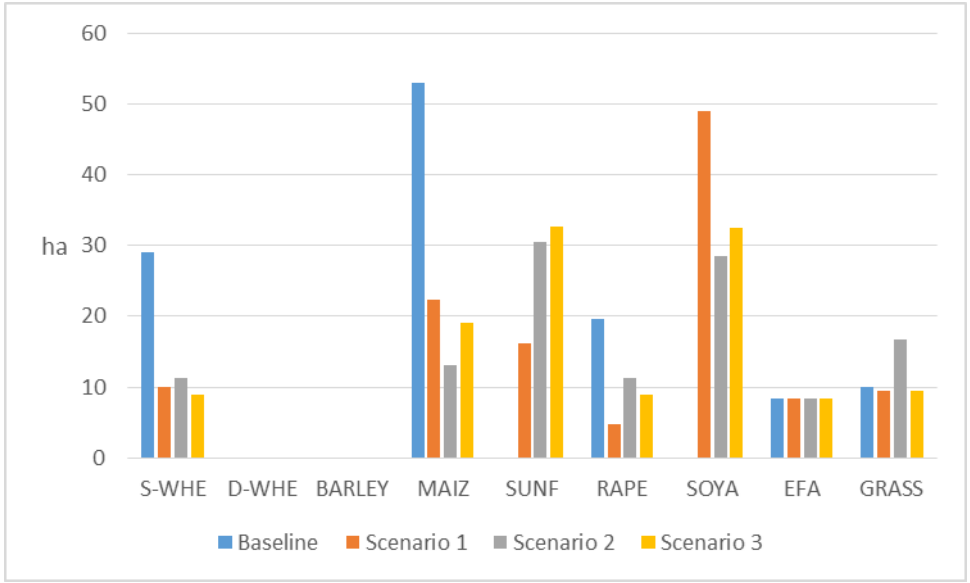
Kleftodimos et al.,2021 – Land Use Policy

Results

Farm-type 1



Farm-type 2



- In all scenarios, in both farm-types, the farmers gross margin is increasing due to lower pesticides and managed bees cost;
- Farmers are willing to re-allocate their labor forces towards more profitable crops in terms of price and yield variability;
- Farmer prefers crops which generate higher gross margins with lower yield variability, better labor allocations and a higher use of wild pollinators.

Results

Scenarios	Farm-type 1	Farm-type 2
Scenario 1	**€100/ha**	**€123/ha**
Scenario 2	**€71/ha**	**€98/ha**
Scenario 3	**€110/ha**	**€131/ha**

- Different levels of AES premiums or penalties can be efficiently targeted in order to convince the farmers to adopt the novel practices:
  - ✓ farms' characteristics;
  - ✓ initial levels of wild bees;
  - ✓ labor availabilities;

- These values are lower than the existing AESs in the territory

Results

Wild bees' dual value under wild pollination constraint

Case studies	Scenario simulations	Wild pollination dual value (€/wild bee)
Farm-type 1	Scenario 1	2.55
	Scenario 2	2.88
	Scenario 3	2.88
Farm-type 2	Scenario 1	3.87
	Scenario 2	5.12
	Scenario 3	5.12

Other studies..

- Rucker et al. (2012) => 0.00012$/managed bee - 0.00601$/managed bee;
- Chabert et al., 2015 and BEEWAPI => 0.015€/managed bee.

The marketed value of bees may have been underestimated.

Discussion & Conclusion

- Marginal economic value of pollinators in terms of production costs gain;
- Building resilient farming systems by reducing the use of pesticides and increasing the farm biodiversity (e.g. Perrot et al., 2018);
- Wild bees is a factor which facilitates the adoption of the novel practices by the farmers (Kleftodimos et al., 2021);
- Increase the resilient of farming systems with lower social cost (Havlík et al., 2005);
- These findings may facilitate farmers participation in Ecophyto and regional AESs.

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Thank you for your attention

https://www.pinterest.fr/kristamckernan3/beautiful-bees/