Agroecosystem modeling

A mechanistic approach

Luigi Ponti
www.enea.it
www.casasglobal.org

AR-VR Workshop, Roma
Wed 25 Oct 2017

GlobalChangeBiology project was the first Marie Curie IRG hosted by ENEA

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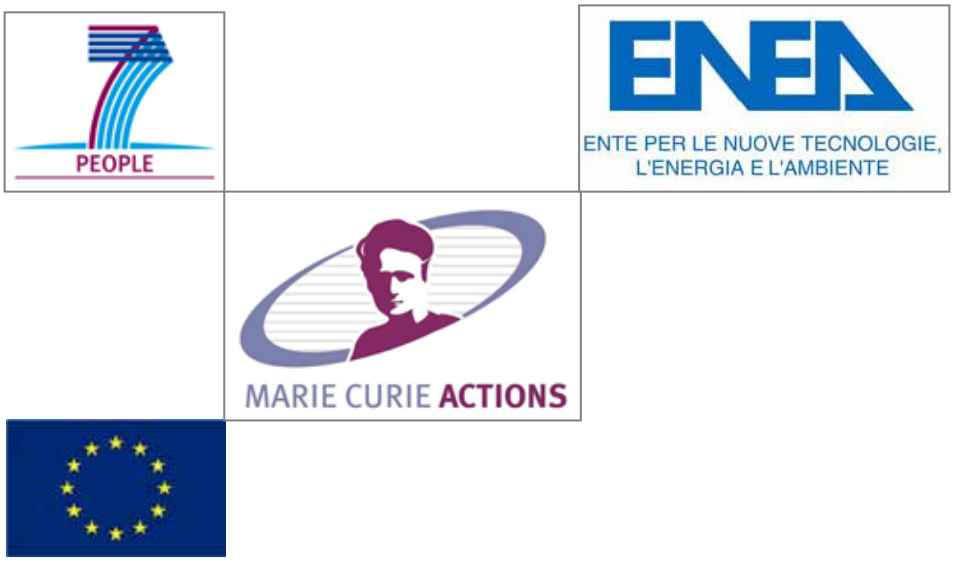

Host

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Collaboration

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More information on the project

globalchangebiology.blogspot.it

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Scientific consortium casasglobal.org
enables continued ongoing collaboration

Analogy among ecological processes may help deal with system complexity

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Processes like predation play
by similar rules in all ecosystems

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Purves et al. 2013, https://doi.org/10.1038/493295a

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Same model describes species biology across trophic levels

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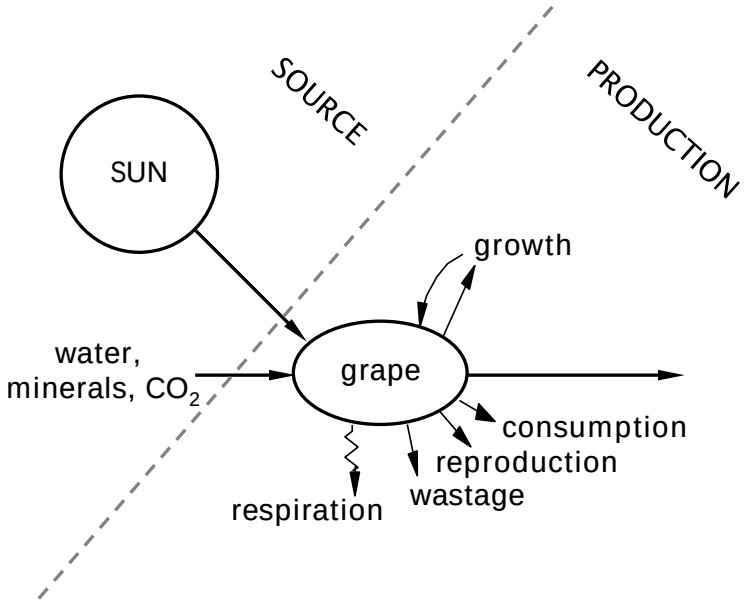
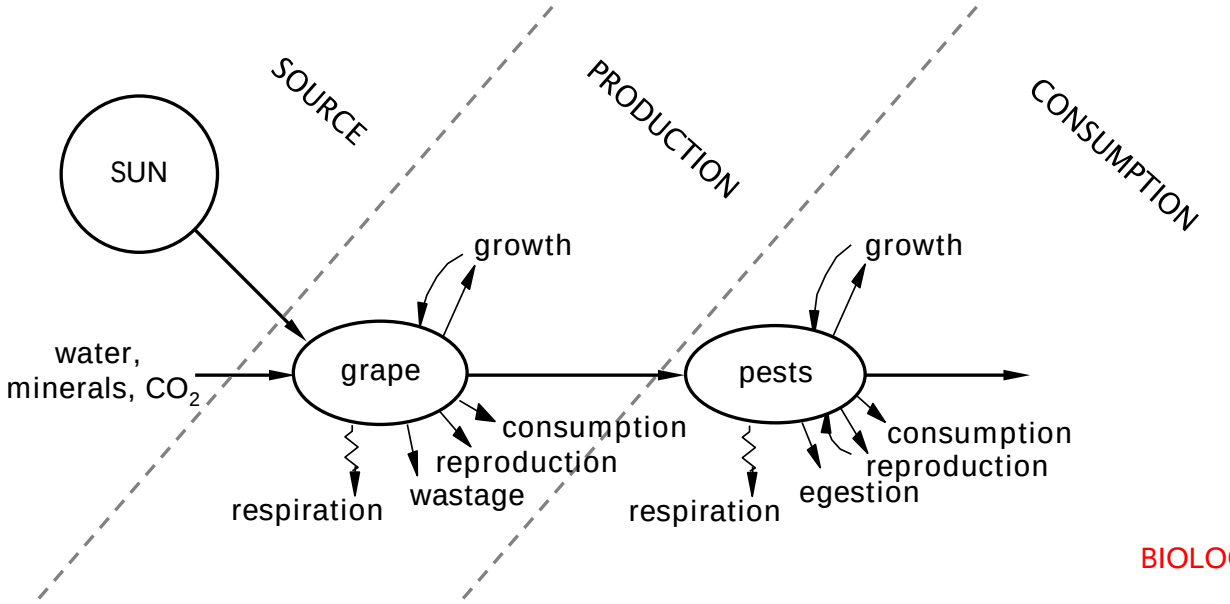


BIOLOGICAL

Gutierrez 1996, https://goo.gl/ejXBWX

Same model describes species biology across trophic levels



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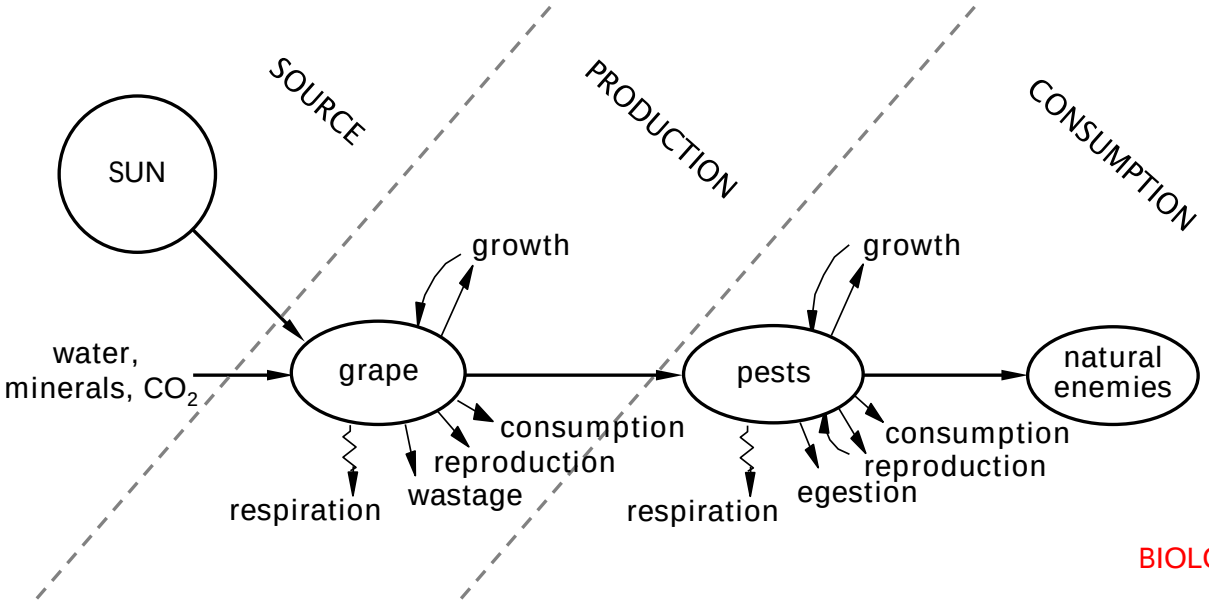

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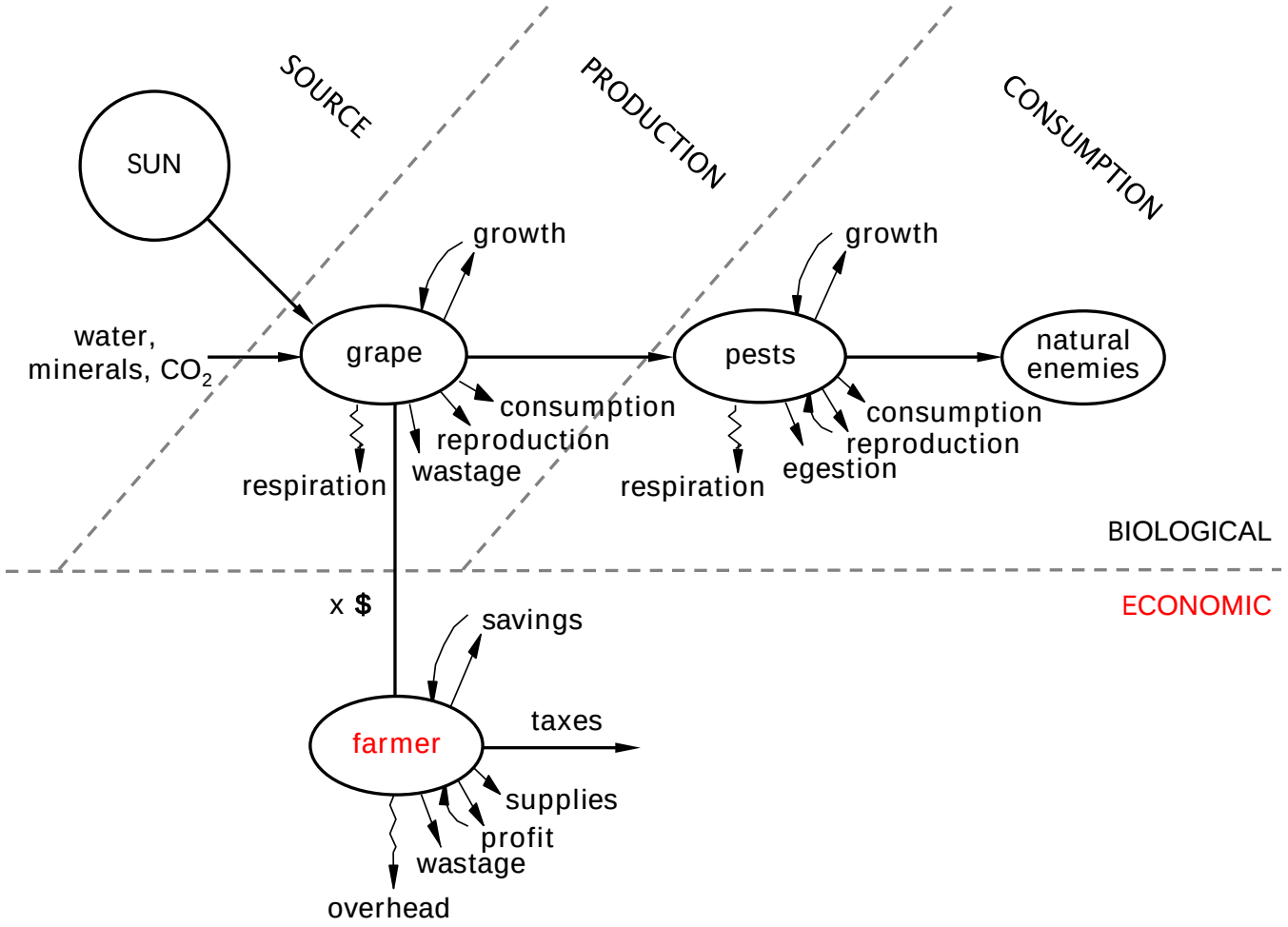
Same model describes species biology across trophic levels including the economic one



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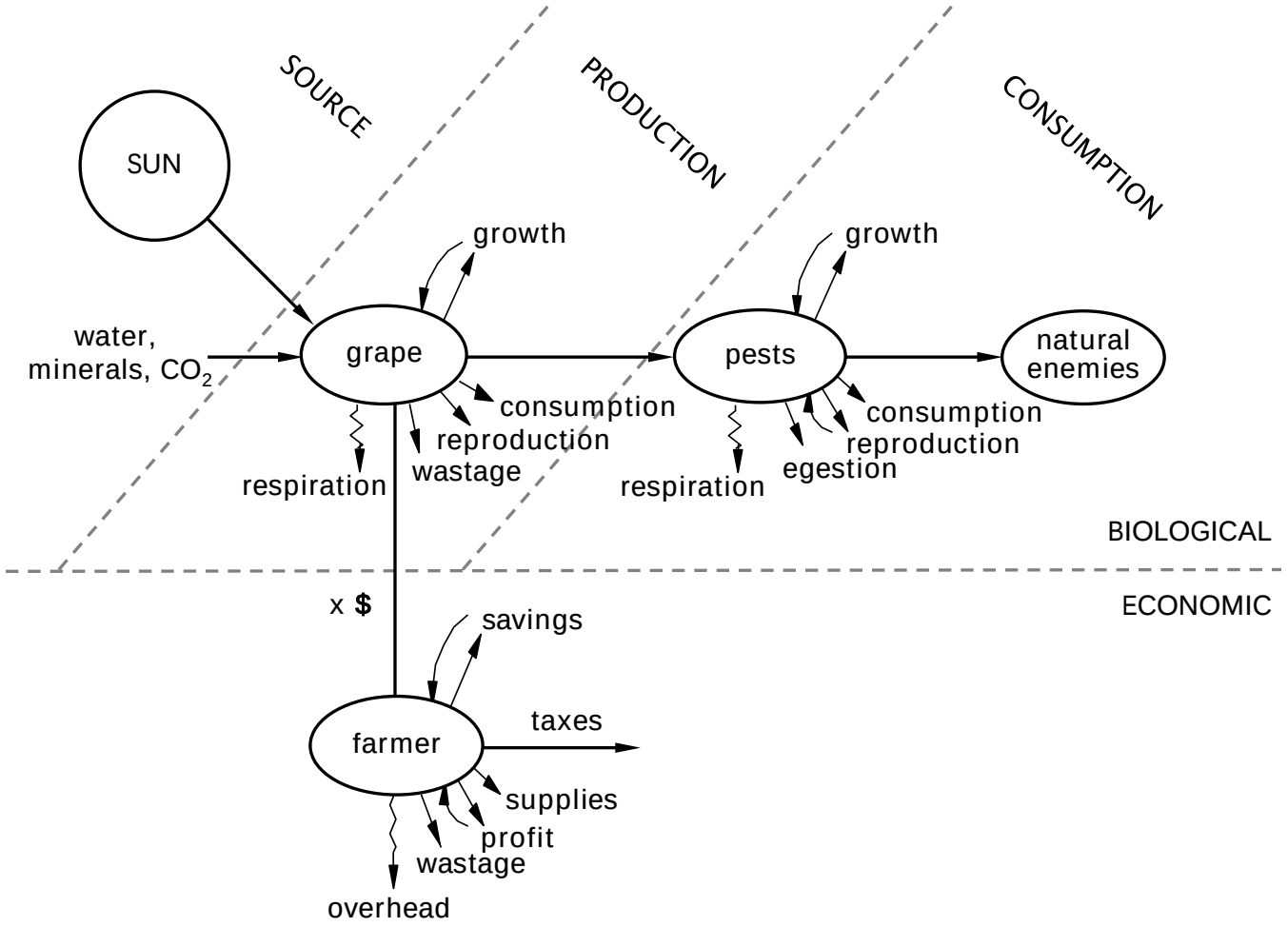
This ecosystem modeling approach is known as Physiologically Based Demographic Modeling (PBDM)



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Agroecosystem modeling

A mechanistic approach

Why complexity is a problem

The scientific point of view

What does it mean in practice

How complexity hinders analysis

How the PBDM approach may help

A realistic geospatial info layer

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IPCC clearly points to ecosystem complexity as a major barrier to assess climate impacts

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Emerging Issues and Key Uncertainties

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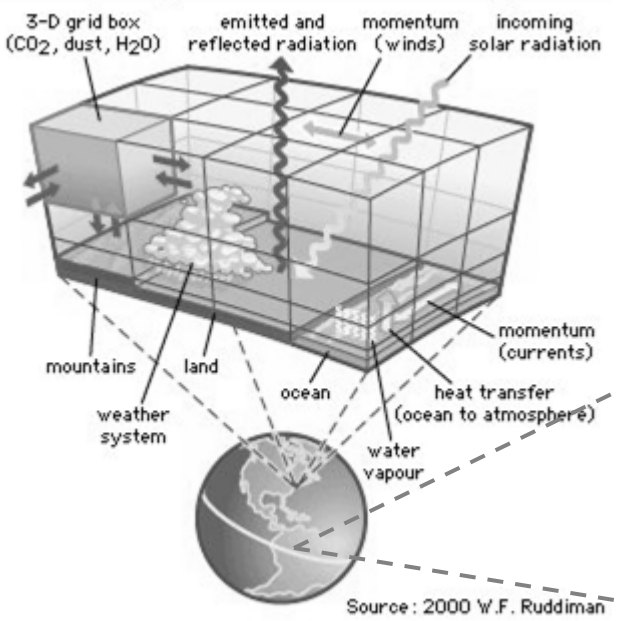
Climate models are widely used,
yet no general ecosystem models exist

Global climate models



No general ecosystem models

Modeling every organism within an ecosystem is impossible

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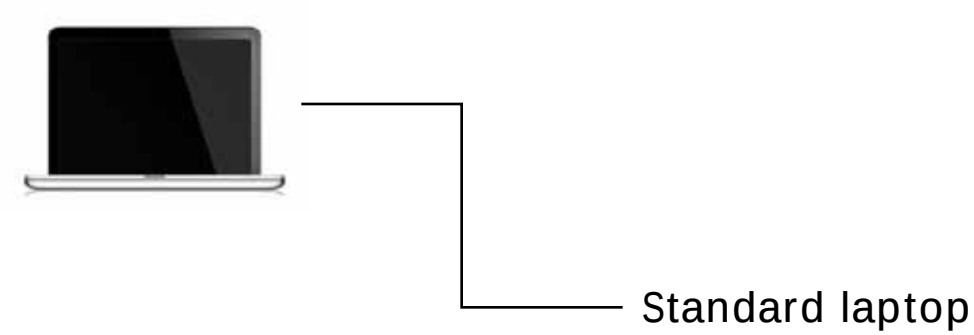

Modeling every organism within an ecosystem is impossible

Standard laptop

100 year simulation

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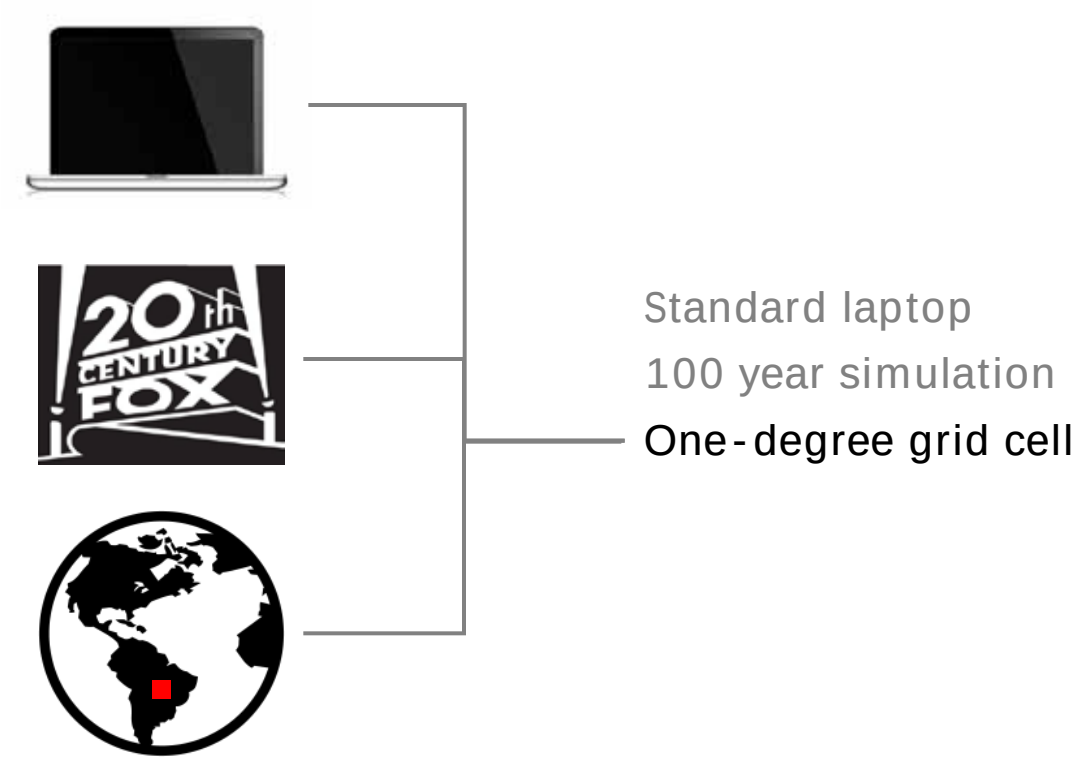

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One-degree grid cell

Only multicelluar animals

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≈ 47 billion years

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A gap exists between bottom-up and top-down approaches to on-ground ecosystem problems

Rocchini et al. 2015, https://doi.org/10.1177/0309133315574659

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Field observations
(bottom-up, scarce and costly)

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Current gap

(scale, reliability, etc.)

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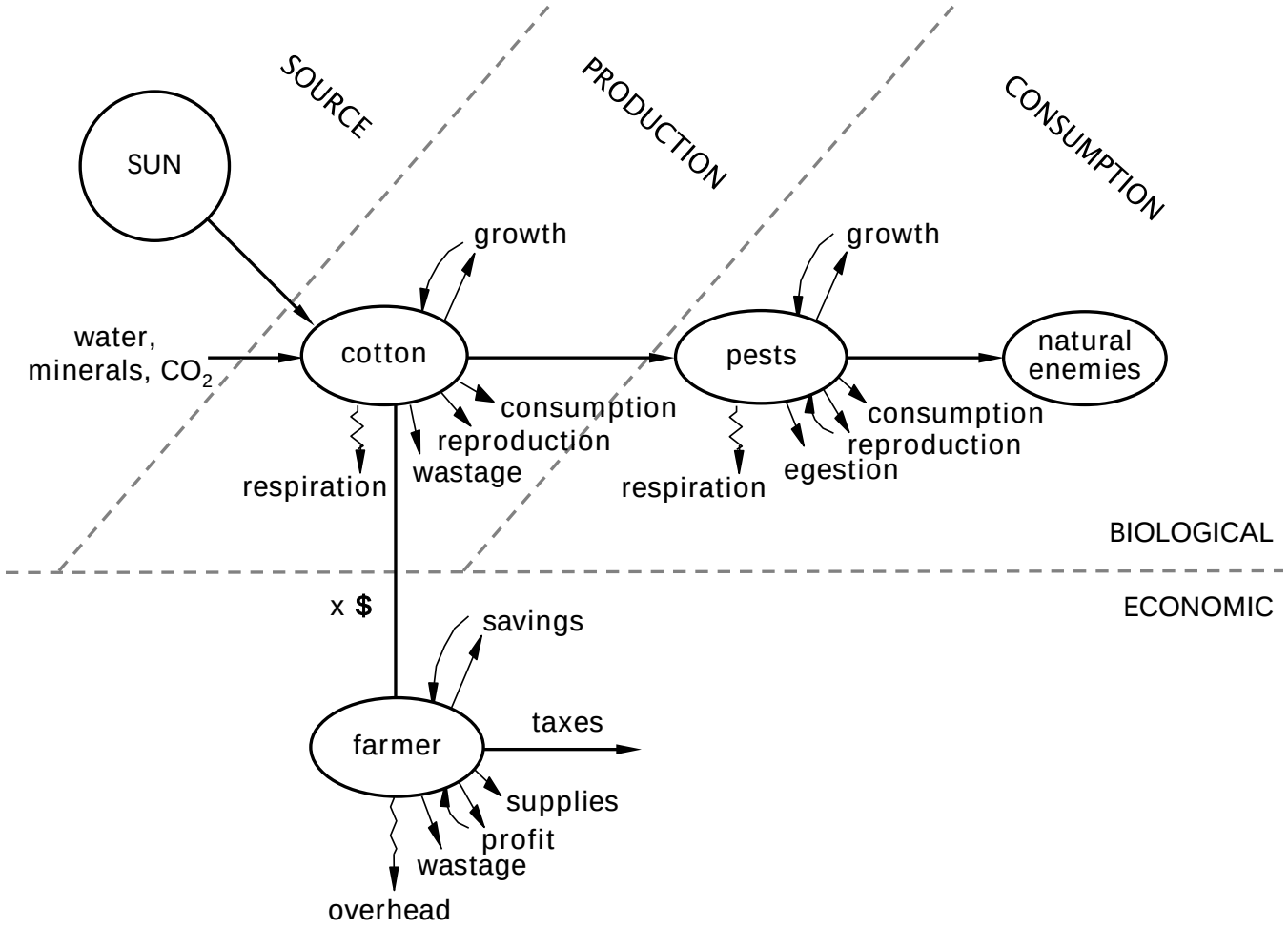

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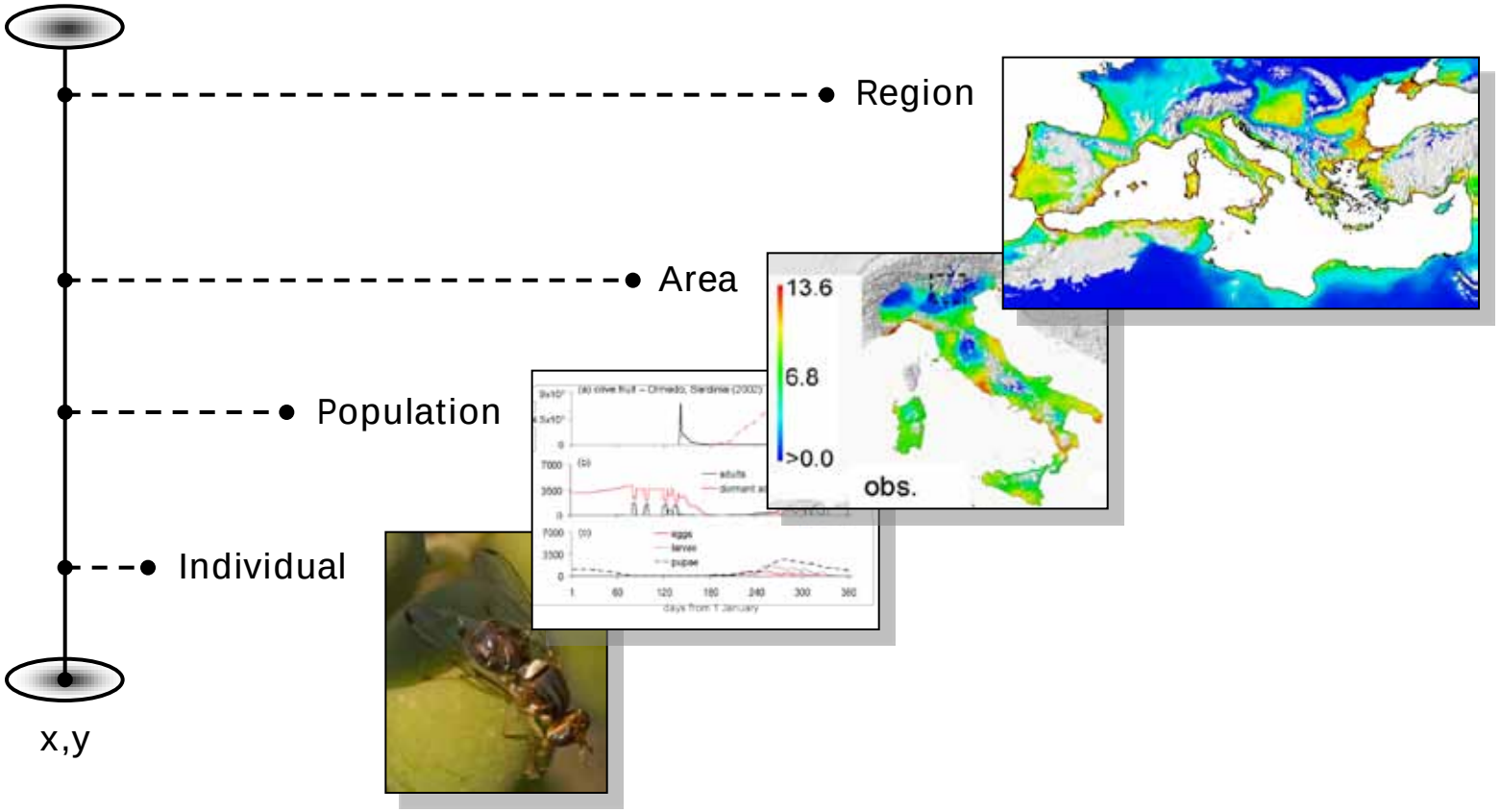
Factors are modeled on a per-capita basis, GIS integration occurs at the population level



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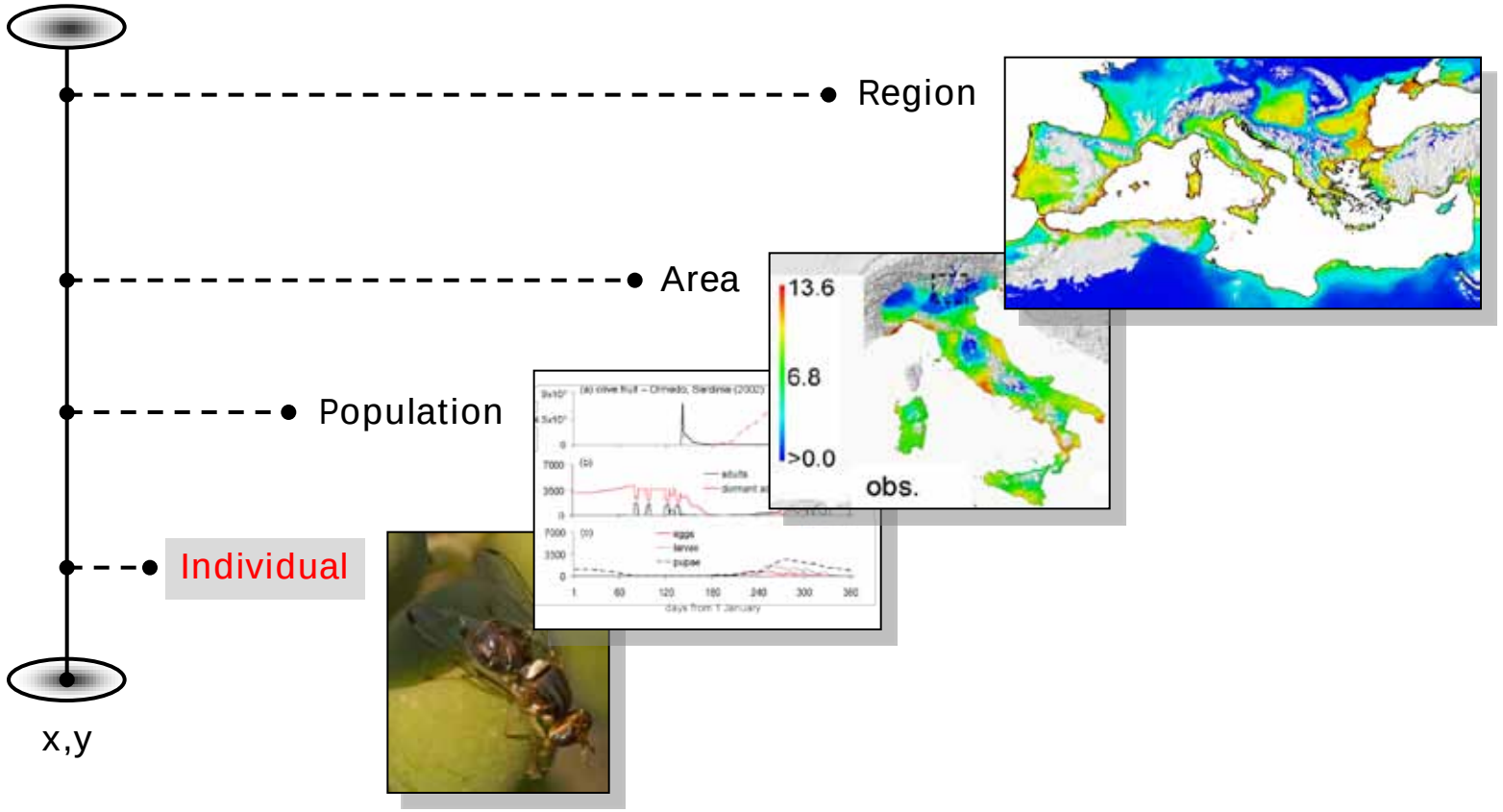

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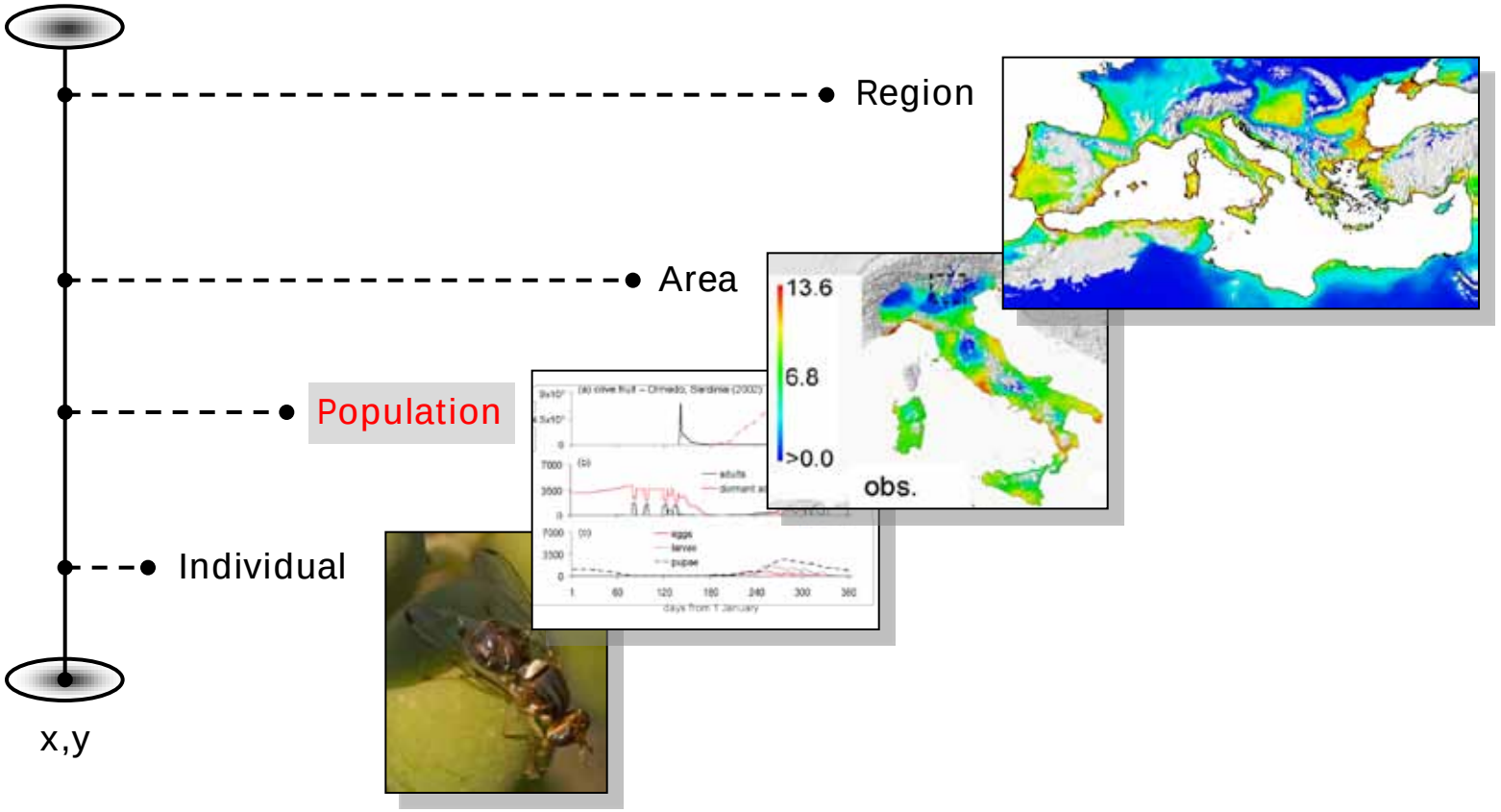

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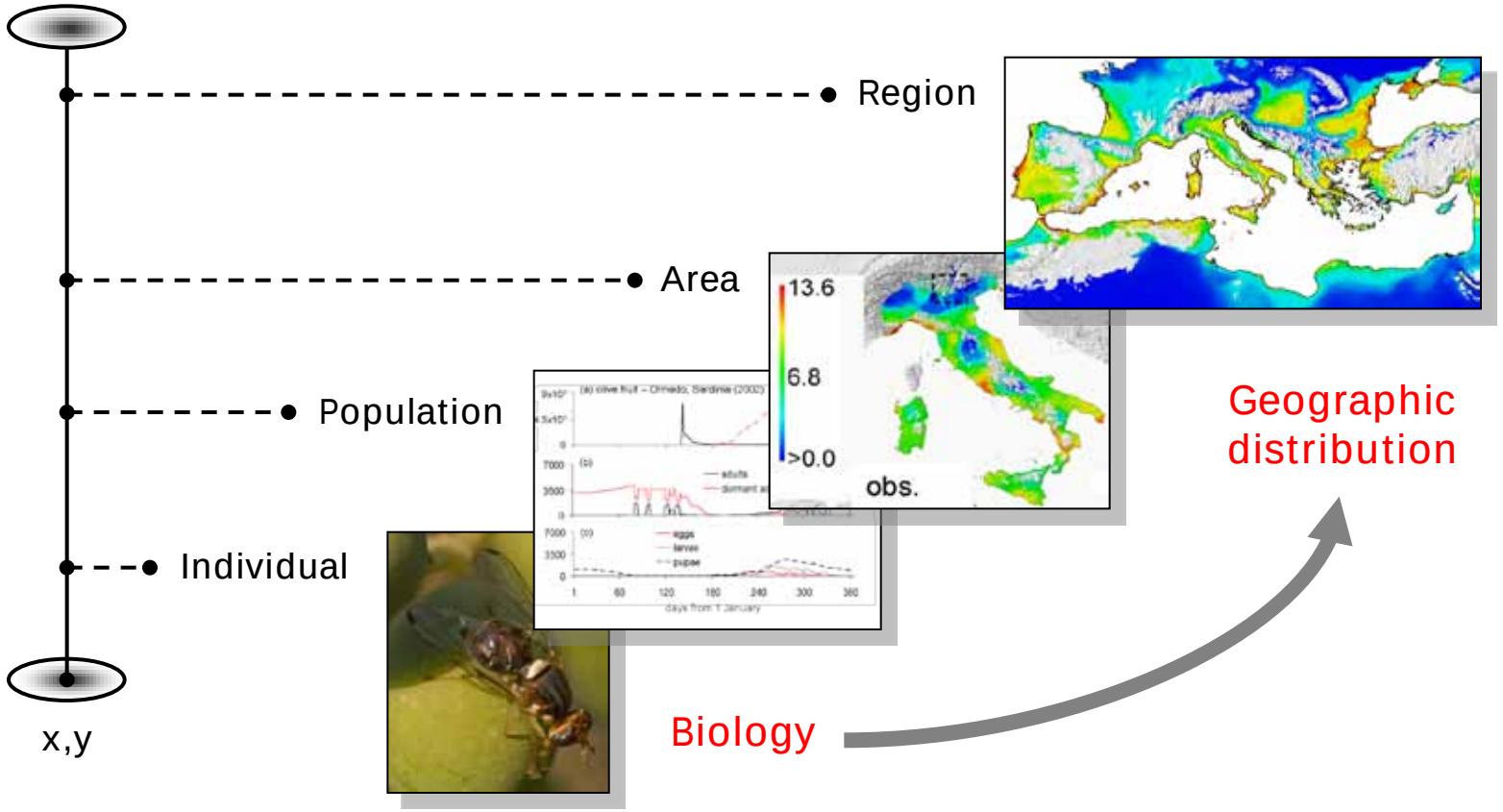

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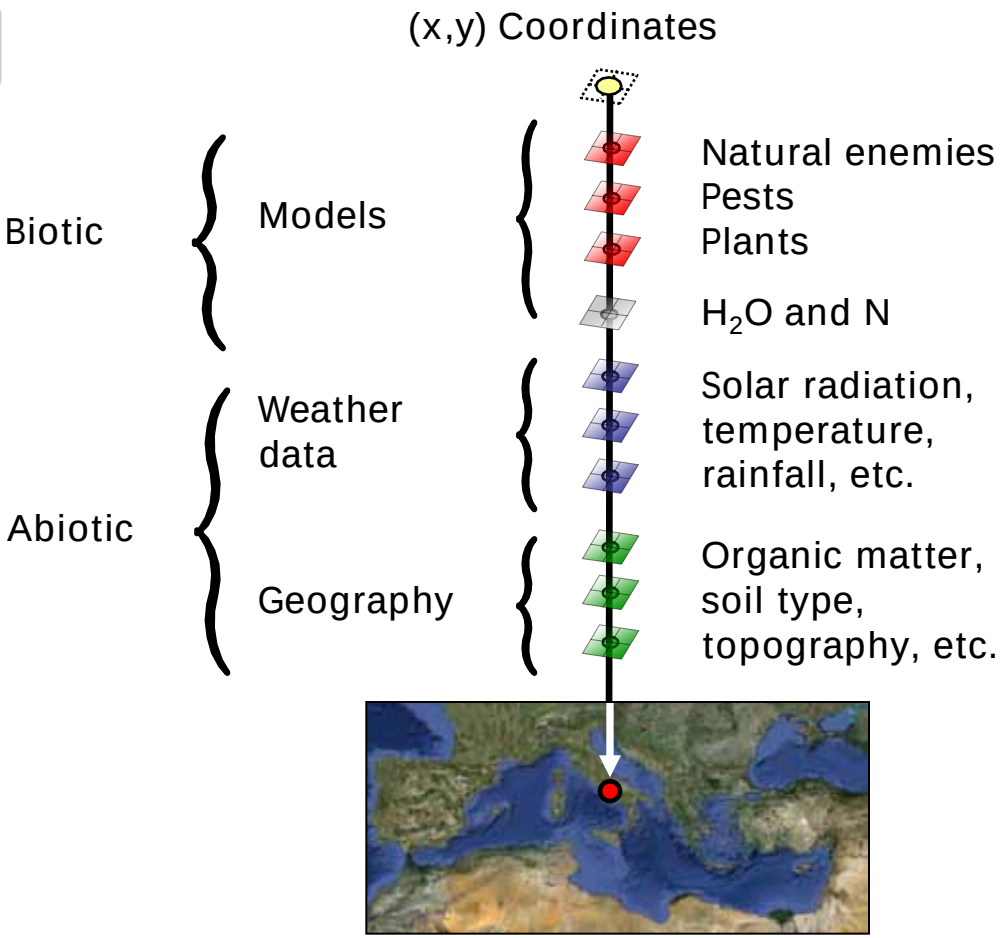
PBDMs become a realistic biological layer having same time/space coverage of driving info layers

Geographic scale



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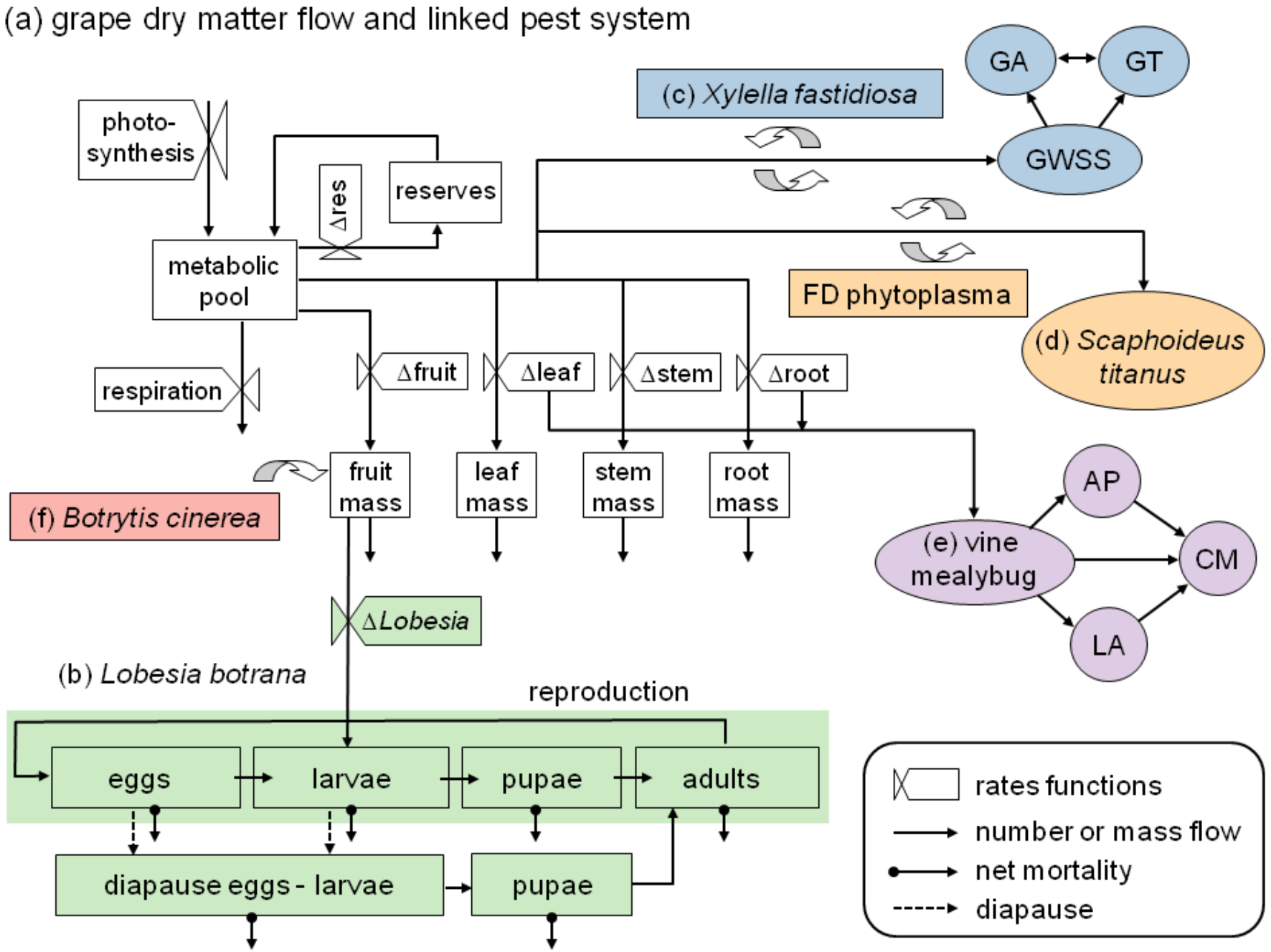
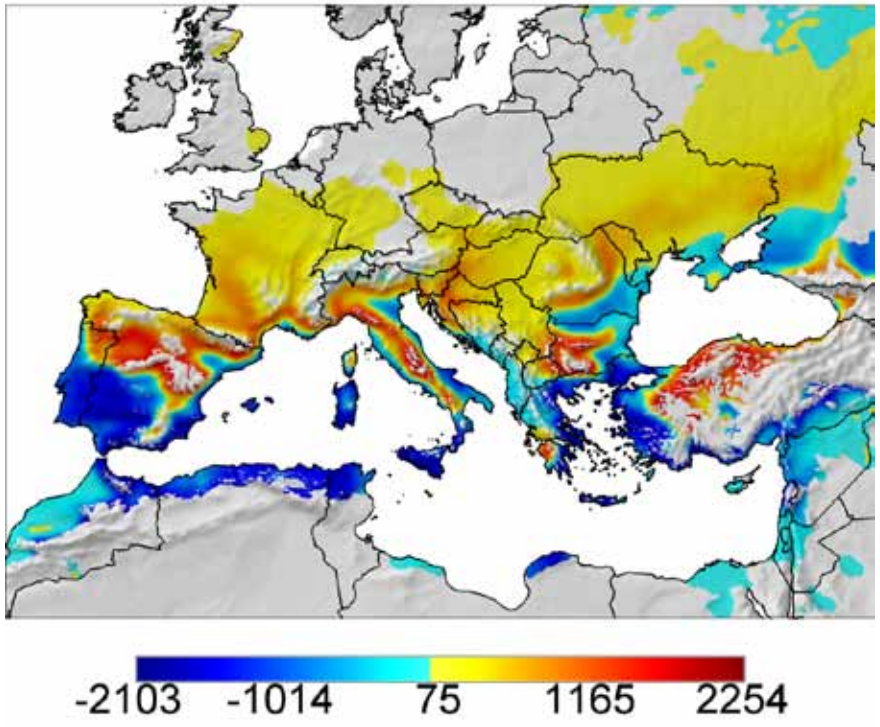


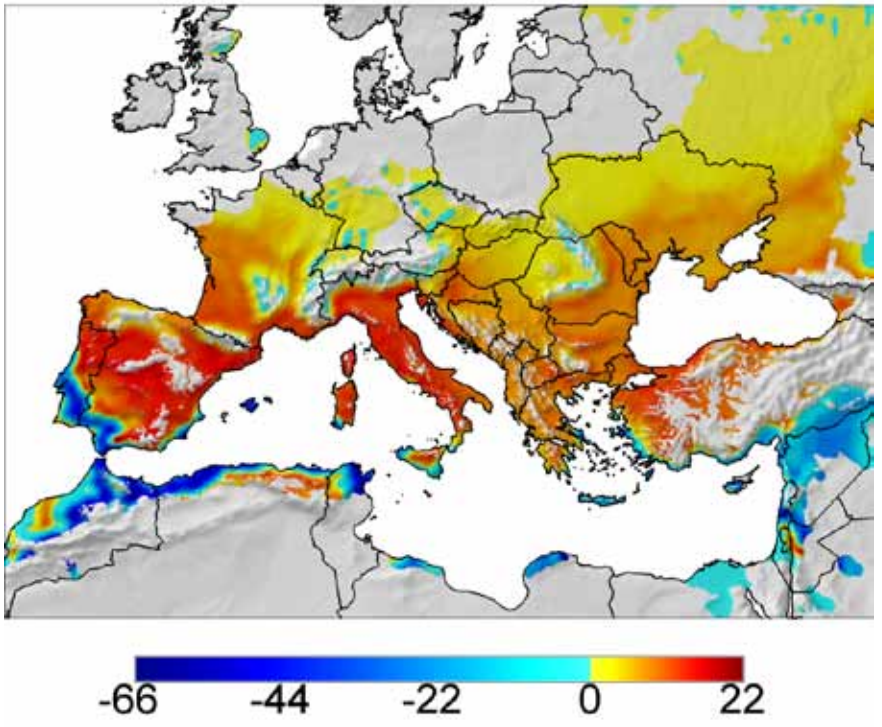
Gutierrez et al. 2017, https://doi.org/10.1111/afe.12256

Projected 1.8 ℃ warming shows a wide range of effects on grape and its major insect pest

Change in yield (g dry matter per vine)



Change in pest (n per vine per year)



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A European research and innovation

Roadmap for Climate Services

Turning climate-related information
into added value for European food systems

MED-GOLD

Upcoming Horizon 2020 project under topic SC5-01-2016-2017 https://goo.gl/wqztJa

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L’approccio alla simulazione degli agroecosistemi nel progetto ENEA GlobalChangeBiology

Luigi Ponti[1,2], Andrew Paul Gutierrez[2,3], Massimo Iannetta[1]

[1] Agenzia nazionale per le nuove tecnologie, l’energia e lo sviluppo economico sostenibile (ENEA), Centro Ricerche Casaccia, Via Anguillarese 301, 00123 Roma, Italy, luigi.ponti@enea.it (LP); massimo.iannetta@enea.it (MI)

[2] Center for the Analysis of Sustainable Agricultural Systems Global (CASASA Global), Kensington, CA 94707-1035, USA, http://casasglobal.org

[3] College of Natural Resources, University of California, Berkeley, CA 94720-3114, USA, casas.global@berkeley.edu

Further info

Ponti, L., Gutierrez, A.P., Iannetta, M., 2016. Climate change and crop-pest dynamics in the Mediterranean Basin. ENEA Technical Report, 27: 18 pp.

http://hdl.handle.net/10840/8042

Workshop “La realtà aumentata e virtuale in agricoltura: sfide e strumenti per il sostegno di progetti innovativi”, 25 October 2017, Roma, Italy