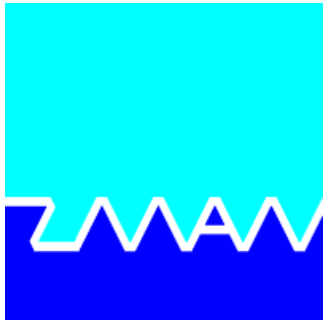




# Land Use in Economic Models

Richard S.J. Tol  
Economic and Social Research Institute  
Hamburg, Vrije and Carnegie  
Mellon Universities

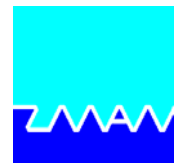




# Classics



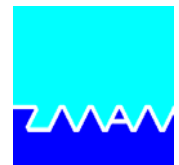
- Economics started as management of large farms - agriculture and land dominated
- The Physiocrats believed that land is the true source of value (cf. Wackernagel)
- The Classical economists were also much into land and agriculture
  - Decreasing RTS: Farmhands on a field
  - Externalities: Beekeeper and farmer
  - Ricardo still makes the AER
- Von Thuenen's concentric circles, Zipf's Law for city sizes, Christaller's lattice





# Modern Times

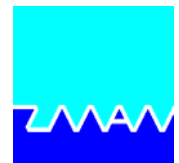
- Later, land use was relegated to subdisciplines
- Partly, this is because land is really important only in agriculture, and agriculture is not really important anymore
- Krugman (OREP, 1998) offers another reason: Before 1977 we were too dumb
- Without congestion, we would all live in the same place
- Without agglomeration benefits, we would be spread evenly over the world

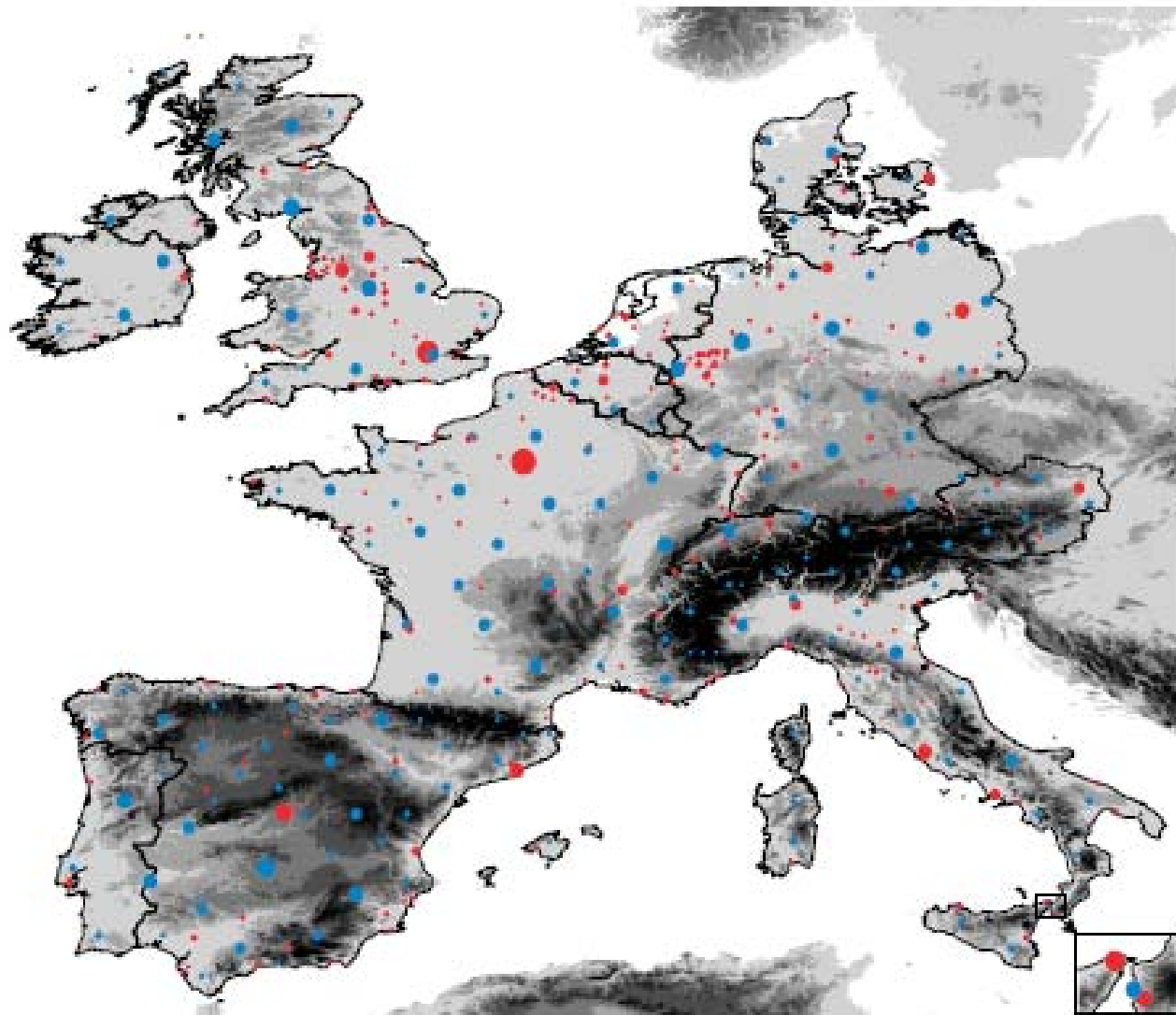




# New Economics

- Since 1991, much progress has been made in new economic geography
- Cities exist!
- From the same roots, new international economics emerged
- Rossi-Hansberg (AER, 2005) merged the two, and shows that tariffs and transport costs are very different things
- However, nice theory, but little application





## Modelled and observed cities in Europe

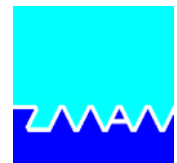
Sea transport and altitude are the only exogenous variables

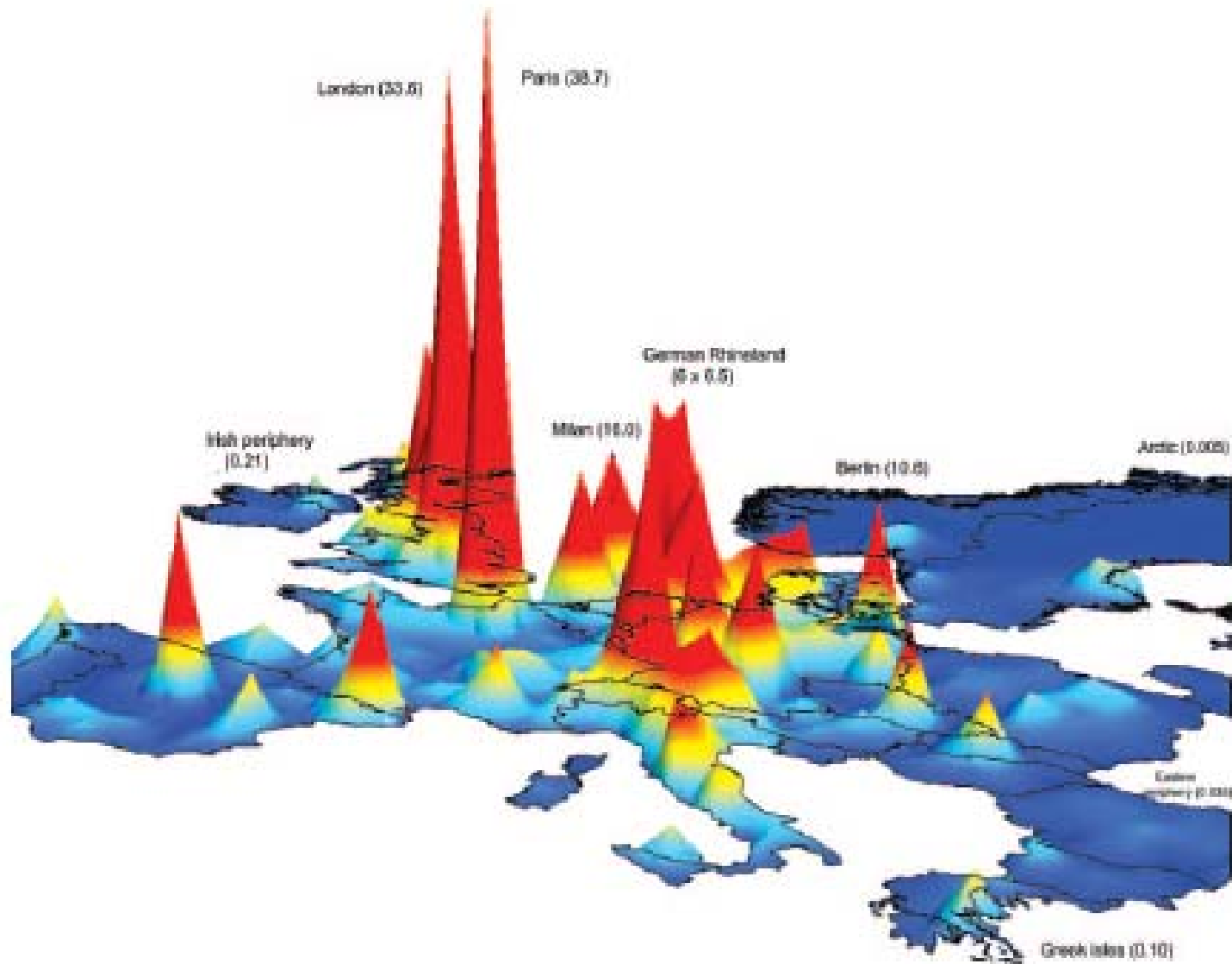
Source: Stelder, J. Reg. Sci., 2005



# New Economics

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- Cities exist!
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- Rossi-Hansberg (AER, 2005) merged the two, and shows that tariffs and transport costs are very different things
- However, nice theory, but little application, partly because of lack of data



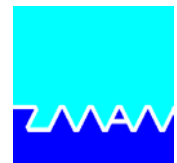


**Gross Cell Product**  
Source: Nordhaus, PNAS, 2006



# Bioeconomics

- There are other developments too
- Plants and animals are increasingly modelled as net energy minimisers
- Some vegetation models are solved as a Nash equilibrium
- Tschirhart (J Theo Biol, 2000) has developed general equilibrium models of ecosystems, with Homo Sapiens as the top predator
- Eichner and Pethig (JEEM, 2006) extended this to land use - and get the island hypothesis as a result
- Still few applications



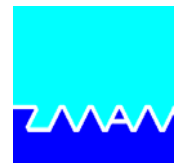




# Land Use and EMF22



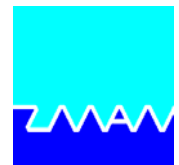
- What does this all imply for the down-to-earth, pre-1977 modellers at EMF?
- In the long run, our models are all obsolete
- For now, we can be useful
- For those who rely on GTAP, land has always been there as an endowment
- With bio-energy and sequestration, we need to take a harder look at land, and particularly competition for land by food production, energy production, and carbon sequestration
- New data allow us to do this!





# Land Use Issues

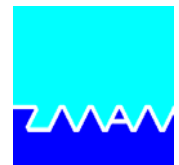
- Intensive v extensive margin
  - Physical v economic units
  - Spot v forward markets
  - Other demands for land
  - Externalities
- 
- All of this can be done with standard tools and new data - plus creativity and hard work
  - It does not require a drastic overhaul of the model, and it does not require a 2D representation of land use!



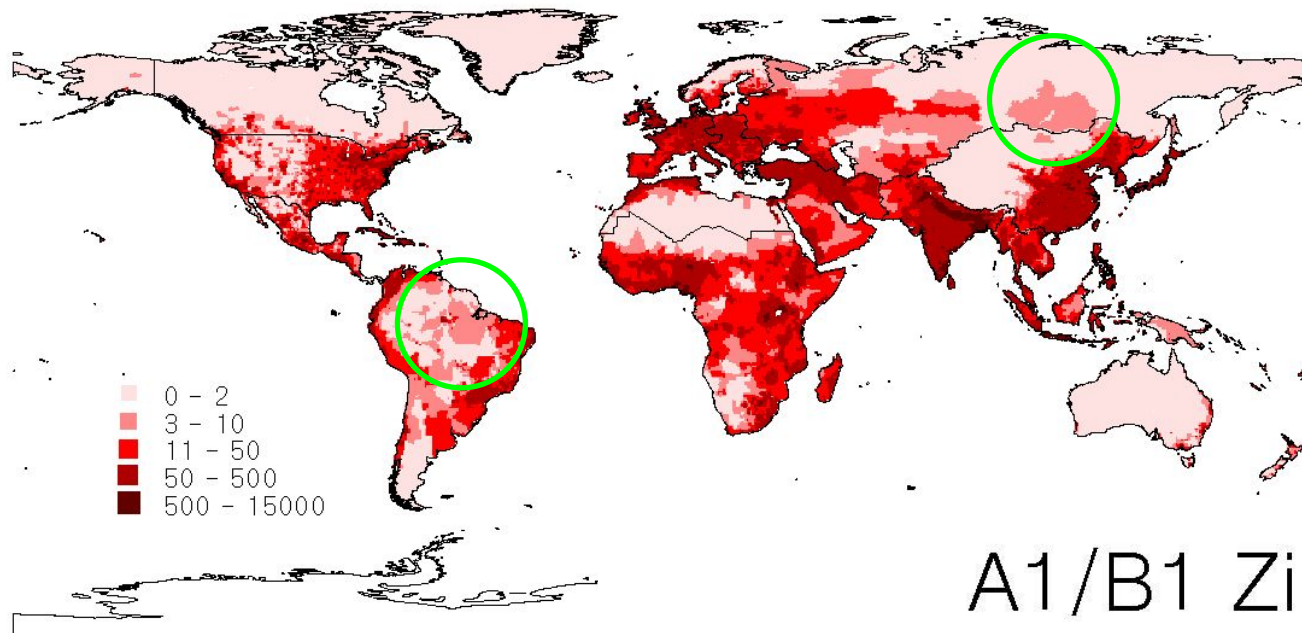


# Land Use in IAMs

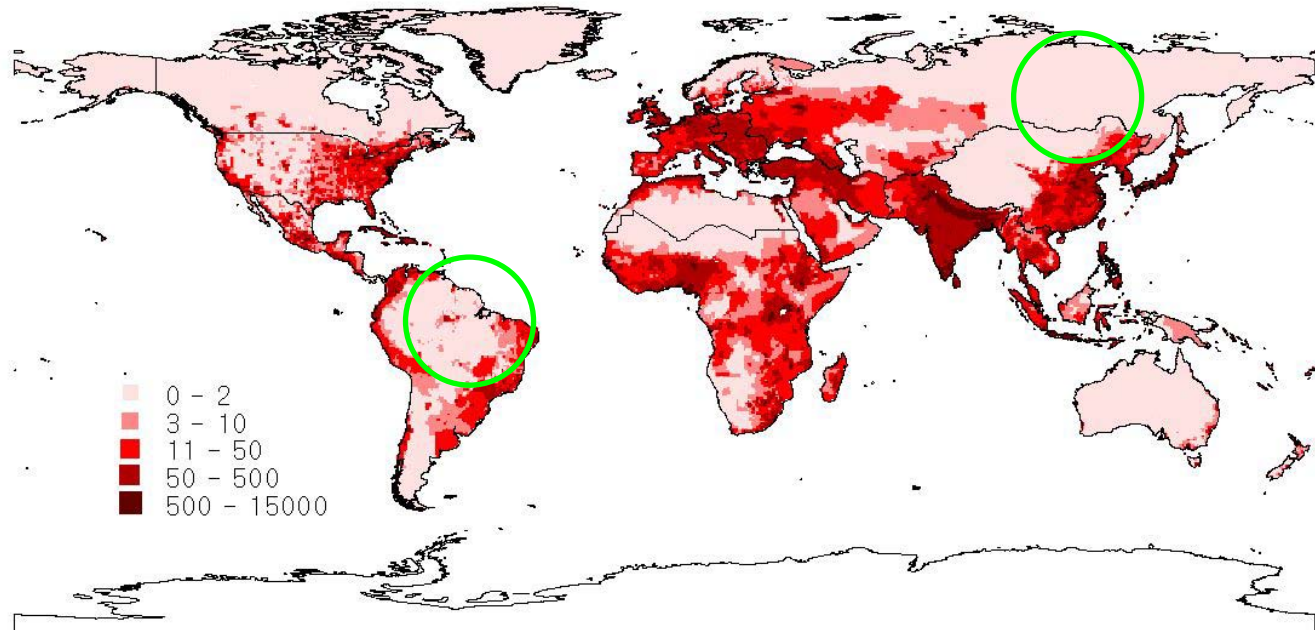
- A spatial representation of land use is not necessary to understand food and energy production and sequestration
- It is necessary, however, if you want to understand nature
  - Biodiversity
  - Eutrophication
  - Albedo
  - Soil carbon
- New uncertainties will be introduced



# A1/B1 CIESIN 2100



# A1/B1 Zipf 2100

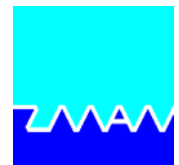




# Land Use in IAMs (2)



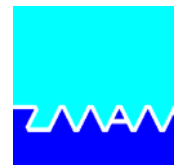
- There are various ways to include spatially explicit land use
  - Nest a rule-based model (FARM, IMAGE)
  - Nest a micro model (AgLU, IFPRI, FARM)
  - Nest an optimisation model (a la MERGE, FASOM-Macro)
  - Nest a spatial equilibrium model (...)
  - Build a new trade / new economic geography model with multiple species
- Current work will reveal the strengths and weaknesses





# Conclusions

- There is a new body of theoretical literature emerging that will totally alter the way we model land use
- Not now, though
- For a number of applications, land use would be overkill - land supply is enough
- For other applications, land use is essential - with new challenges for theorists and practitioners alike





# A Pioneer

- Roy Darwin pioneered land use in a CGE - however, if you take a close look at FARM, then they just had six land endowments rather than one, and the six only differed in productivity
- The land endowments were the sum from a GIS, but that was just input
- The spatial patterns in the GIS had nothing to do the CGE - only the totals matched
- GTAP-AEZ follows this, but with much superior data and better production functions

