

Climate and Society: Lessons from the past 10,000 years

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The importance of the long term

- Including the long-term dynamics
 - Tectonics over 10^5 years
 - Cultures over 10^3 years
- Observing complete cycles
 - Not only the last 100 or so years
 - Observing wider range of behaviors
 - Correcting for bias
- Observing the change of change
 - Risk shift towards unknown long-term risks (time bombs)
 - From long-term investment to short-term 'dealing'

The role of archaeology

- Need to complement polar climate data
 - Evolution of terrestrial environment (soils, rivers, flora, fauna)
 - Evolution of human behavior
 - Downscaling from global to regional
 - Mitigation to adaptation
- Archaeological record the only one at the timescales involved
 - Omnipresent, integrates all sources
 - Modern archaeology is in part an environmental science
 - Sometimes difficult to interpret
 - Slow process, long correction cycle

How does archaeology do it?

- Geoarchaeology (mineral remains):
 - Geomorphology: erosion, soil formation
 - Micromorphology, biogeochemistry
- Archaeozoology (animal remains):
 - Animals, herds, diet, parasites, coproliths
- Archaeobotany (plant remains):
 - Pollen, tree rings, charcoal, fruits & seeds, phytoliths
- Bioarchaeology (human remains):
 - Genetics, life span, population dynamics, pathology
- Dating (everything possible):
 - Radiometric (^{14}C etc.), OSL, varves, dendro, etc.

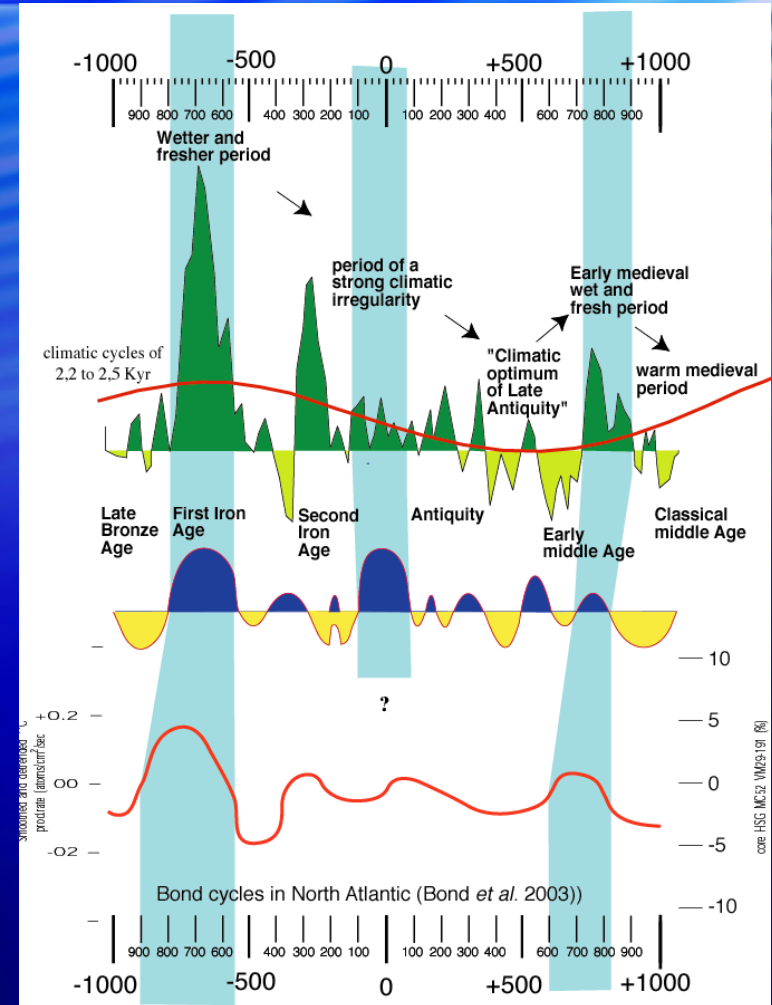
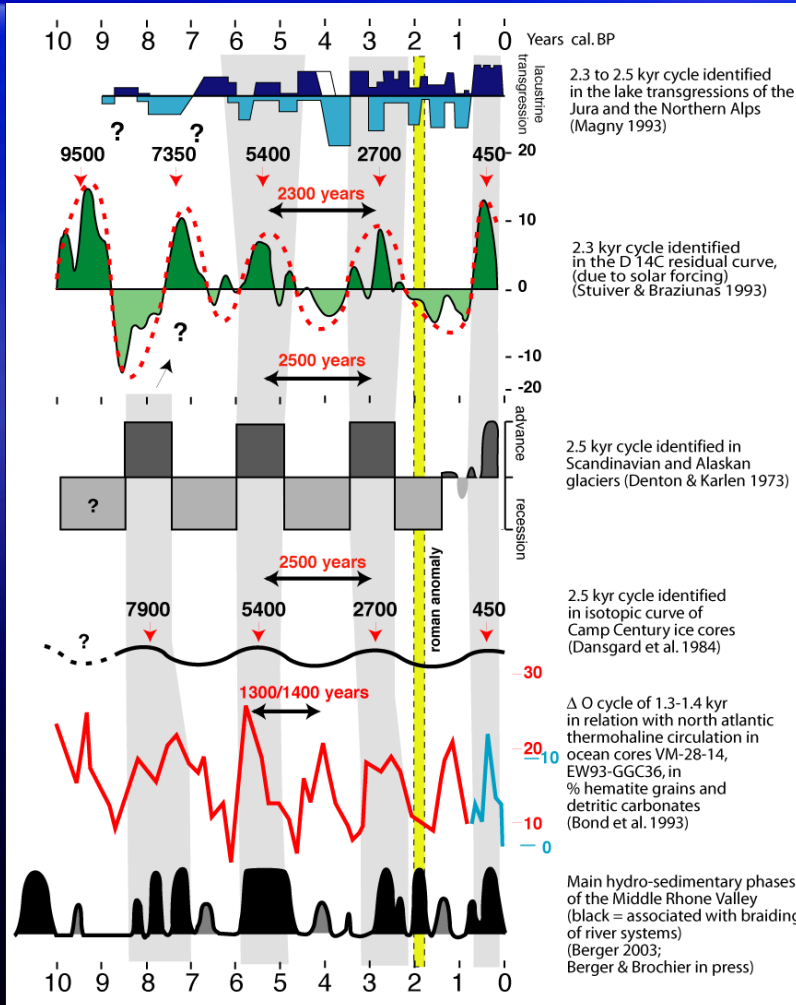
The main difficulty is in the timescales

- Socio-natural phenomena are multi-temporal
 - Natural and social dynamics operate at an infinite number of scales, from the millennium to the minute
 - Any conjunction can trigger changes ... how do we find out what 'did it', and what the role of the social or the natural is ?
 - Climate studies must downscale from the global, archaeological studies must upscale from the local
 - Different disciplines, different ways to deal with time
 - Different degrees of precision
- Contingency is not always causality
 - Much archaeology operates on internal consistency, rather than external proof

Multi-temporal oscillations

- Glaciation cycles of 100-, 43-, 24-, 19,000 years
 - Milankovitch (excentricity, inclination of earth's axis, precession) change distance of surface to sun ...
- Cycles in N American Icebergs c. 7,000 years
 - Heinrich events, not yet adequately explained, cool N Atlantic climate for decades (-4°)
- Cycles in ice cores ($\Delta_{18}\text{O}$) of c. 2,500 years
 - Dansgaard - Oeschger cycle 10^0 in $n.10^3$ years
 - Also found in $\Delta_{14}\text{C}$, Scandinavian glaciers, etc.
- Cycles in foraminifera $\Delta_{18}\text{O}$ of c. 1,400 years
 - Bond events: slower thermohaline circulation, colder climate (-10^0).
- Last major event c. 8,200 BP:
 - Emptying of Canadian lakes (100,000 km² of cold water) in N. Atlantic

Climate oscillations at two scales ...



What ensured survival in the Pleistocene?

- Throughout the Pleistocene, humans survived through the (Ice) ages, by
 - **Harvesting** the environment's offerings
 - A **multi**-resource strategy
 - Adapting to change by **moving**
 - Staying below the environment's carrying capacity
 - Australian famines only in river valleys
- No fundamental change in behavior:
 - People lacked the know-how to **inter**-act with their environment: natural dynamics were independent
 - Change and risk were the order of the day
 - Yet people minimized change
 - Epirus caves inhabited where tectonics keep change limited

Early societies and climate change

- End of Neanderthals due to climate change?
 - Climate change (c.30,000 BP) moves large ungulates south; Neanderthals don't follow, Modern Humans do.
- Beginnings of the Neolithic cause of climate change?
 - Both climate and man can change vegetation cover locally (deforestation, cultivation)
 - C. 8000 BP CO₂ peak – first relatively large increase in population and forest destruction
 - c. 5000 BP CH₄ peak – first rice fields in SE Asia
- Very small populations, very local changes
 - Resolution insufficient to determine causality, but relationship presumably inverted!

Three major 'revolutions' in 10,000 years

- 'Neolithic' revolution: the first villages, the first agriculture, the first domesticated animal herding (10,000-8,000 BP)
- 'Urban' revolution: the first cities (6,000-5,000 BP)
- 'Imperial' revolution: the first multi-community, large, political entities (3,000 BP)

What happened in the Neolithic?

- A fundamentally different way of life...
 - Change in subsistence base: cultivation, herding
 - New technologies: ceramics, basketry, huts
 - Different mode of life: villages
 - Different social life: larger groups
 - Different perception of space & time
- From **harvesting** the environment to **investing** in it. Why?
 - Mobility no longer the way to meet challenges
 - Old system was adapted, could have continued
 - Change in conceptual toolkit evolved during Pleistocene

How did that change the dynamics?

- Reciprocal relationship to environment and climate
 - Climate can change society **and vice versa!**
- Growing interventionism in nature
 - ‘Milieu’ and ‘environnement’ : two perceptions of the same relationship which mutually reinforce interventionism and perception of control
- Survival depends on the adequacy of subsistence and survival techniques
- Sedentary societies try to control environmental risk:
 - Simplify the environment
 - Optimize and narrow the range of natural dependencies
 - Spatial and technical diversification

New relationship with environment

- Problem-solving the key to survival
 - The bigger the challenge, the more important the solution
- Positive feedback between solutions, problems and numbers of people
 - Diversification and specialization
 - Ever larger interactive groups
- Information-processing the dominant driver, energy supply and conflict the main constraints
 - Very energy-intensive (100 watts --> 10,000 watts)
- The cost is growing social complexity
 - Increasing investment in maintaining society
 - As groups grow, cohesion becomes a problem

Sociality becomes the way to survival

- How to combine differentiation and group cohesion?
- Reduction of communication effort leads to sedentism
 - Villages expression of new way of subsistence
 - Towns can not be explained by energy dynamics
- More and more potential for misunderstanding, conflict
 - Need to make communication ever more precise
- Keeping people out as important as keeping them in
 - Language differentiation; identity issues
 - Administration, writing prepare way for state formation
 - Towns and long-distance trade

Investment narrows range of survival strategies

- As the system integrates, it is more vulnerable to external and internal disturbances
- The risk spectrum shifts to unexpected ‘time bombs’
 - Many of these are social or socio-environmental
- The only way out of ‘crises’ is through innovation
- Urbanization facilitates innovation
 - Invention is a local phenomenon, in few cognitive dimensions
 - Innovation requires many cognitive dimensions, thrives in towns, comes to drive urbanization

From cities to states and empires

- Towns emerge as clusters of independent entities (Greece, Etruria, Near East, Maya ...)
- As towns grow, energy/matter networks exceed information networks
 - Long distance trade
 - Cities federate
 - Control over the countryside
- Ultimately, this creates 'Empires', i.e. administrative entities incorporating many nations, cultures ...

What is an 'environmental crisis' ?

- Human survival depends on people finding solutions to problems
 - All solutions involving the environment, ultimately degrade it
 - Humans are not the only species who degrade their environment (e.g. fir trees)
 - There is no sedentary human occupation without environmental degradation (e.g. New Guinea highlands)
- Environmental crises are crises in the **relationship** between society and environment
 - Periods in which a society can no longer deal effectively with its environment
 - The society has invested so much that it cannot innovate itself out of difficulty before time runs out

From population to organization thinking

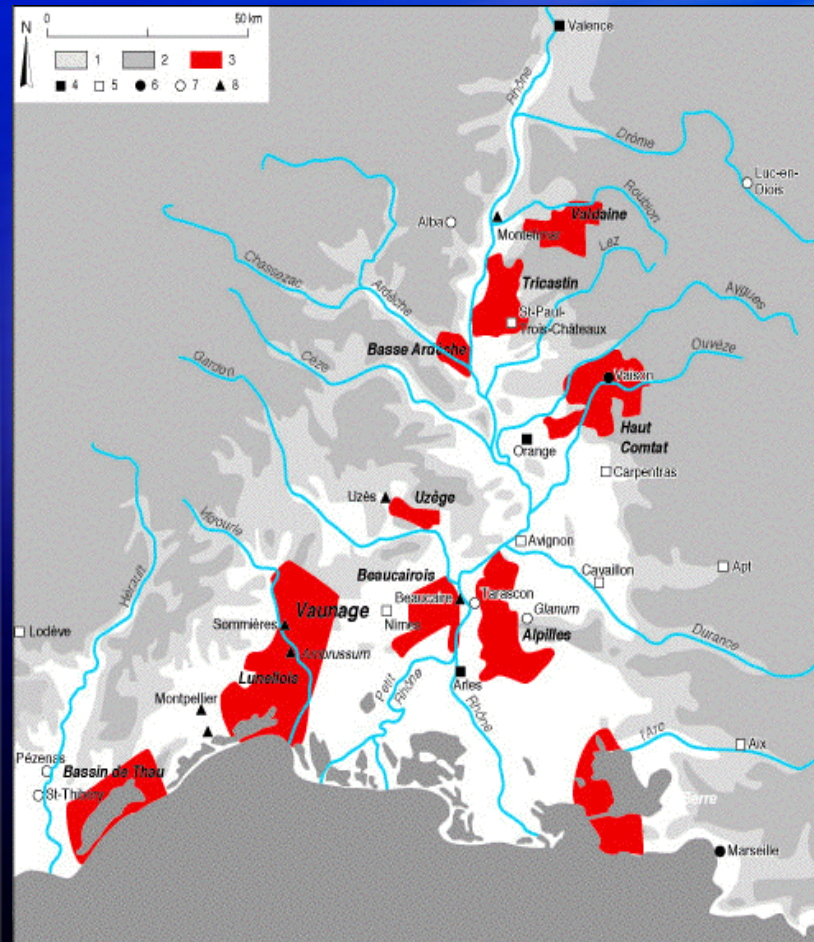
- We all know the many examples Tainter (1988) and Diamond (2004) made famous: Easter Island, the Maya, Rome ...
- We have to think differently about these societies
 - A crisis is not the disappearance of the people, but of the **organization**
- Climate is no longer the sole driver
 - The **balance** between investment and innovative capacity becomes determinant
 - **Internal** perturbations increasingly become important alongside external ones

Comparing two crises in Roman times

The Lower Rhone valley

Two crises:

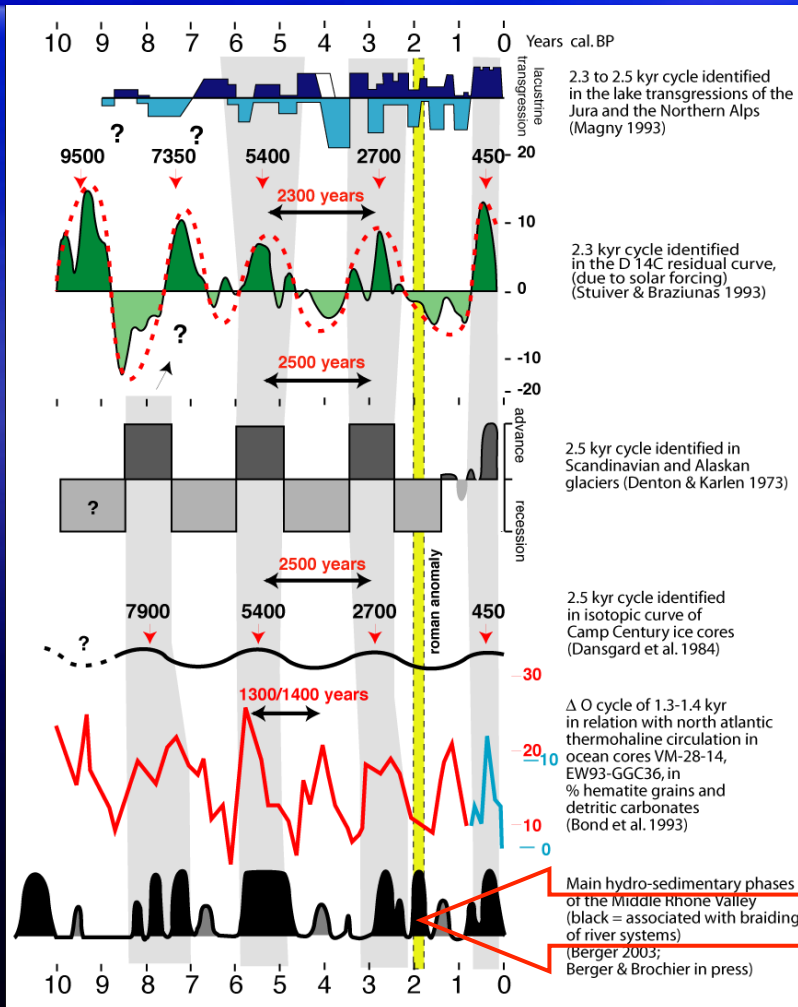
- 2nd & 3rd century
- 6th century



What is special about the Roman period?

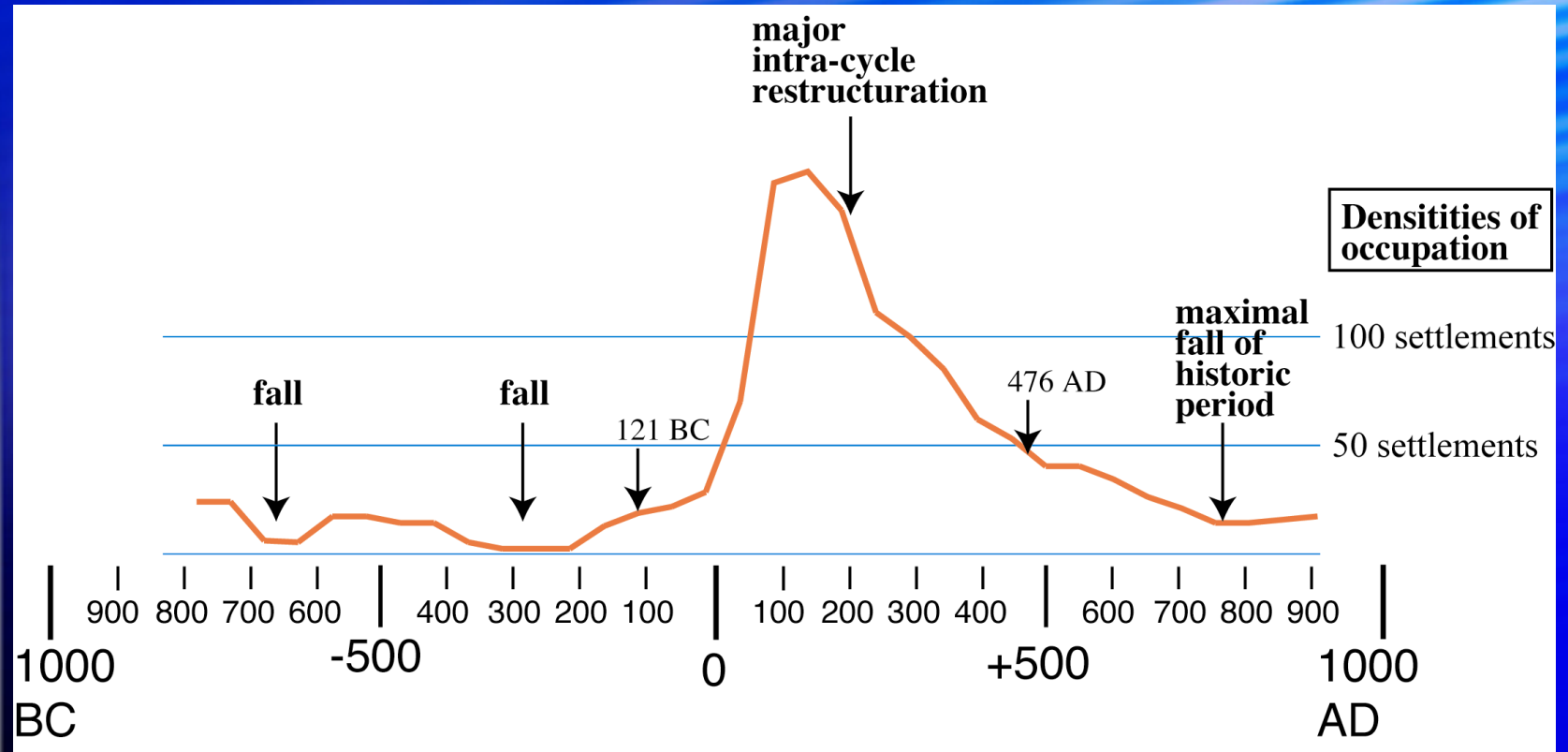
- Exceptional data, refined chronology
 - Map, agronomic descriptions, etc.
- Urban perception of the landscape
 - *Centuriations* (land registers)
 - Irrigation agro-industry
 - Rectangular road systems
 - Drainage works
 - Land re-allotments
 - Aqueducts
- Very similar to our own

A regional anthropogenic crisis ...

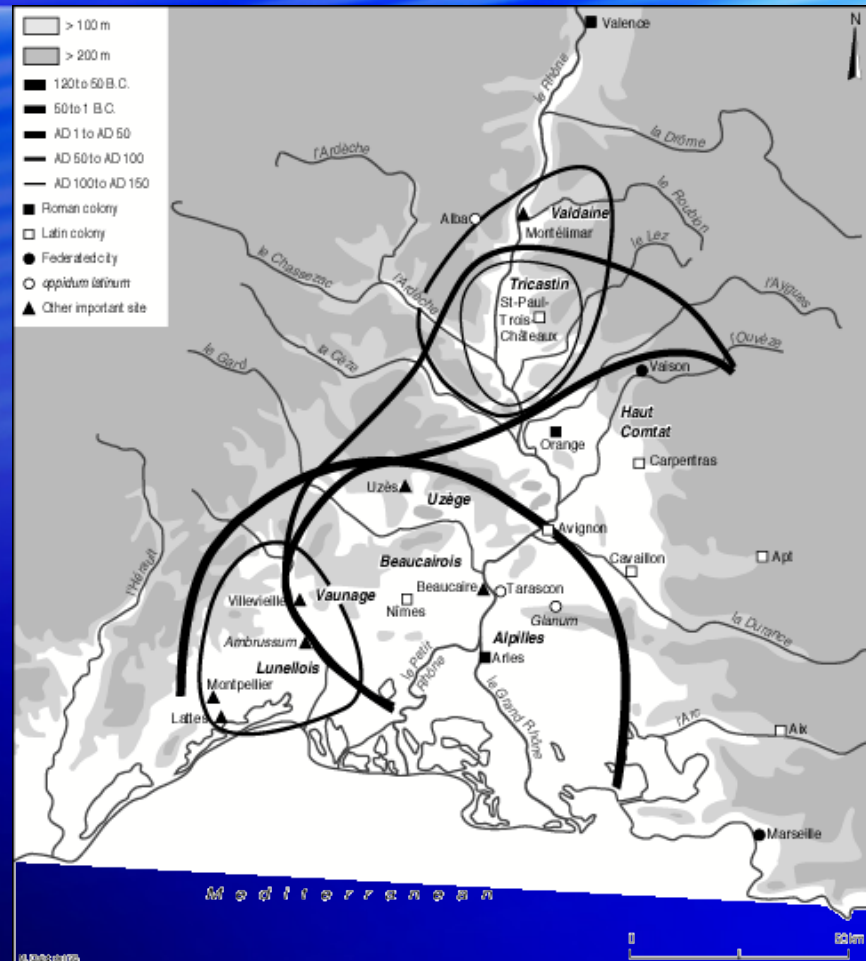
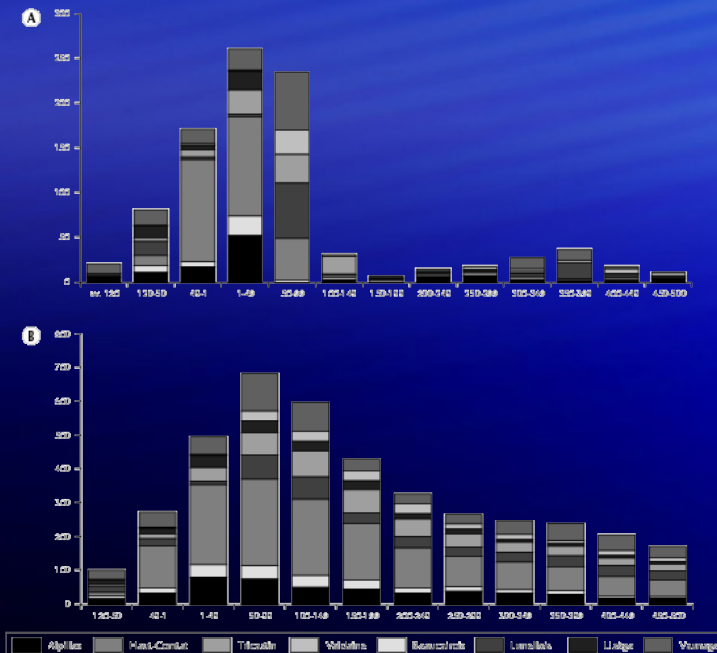


The change is only visible in the Rhone valley, not at the global level

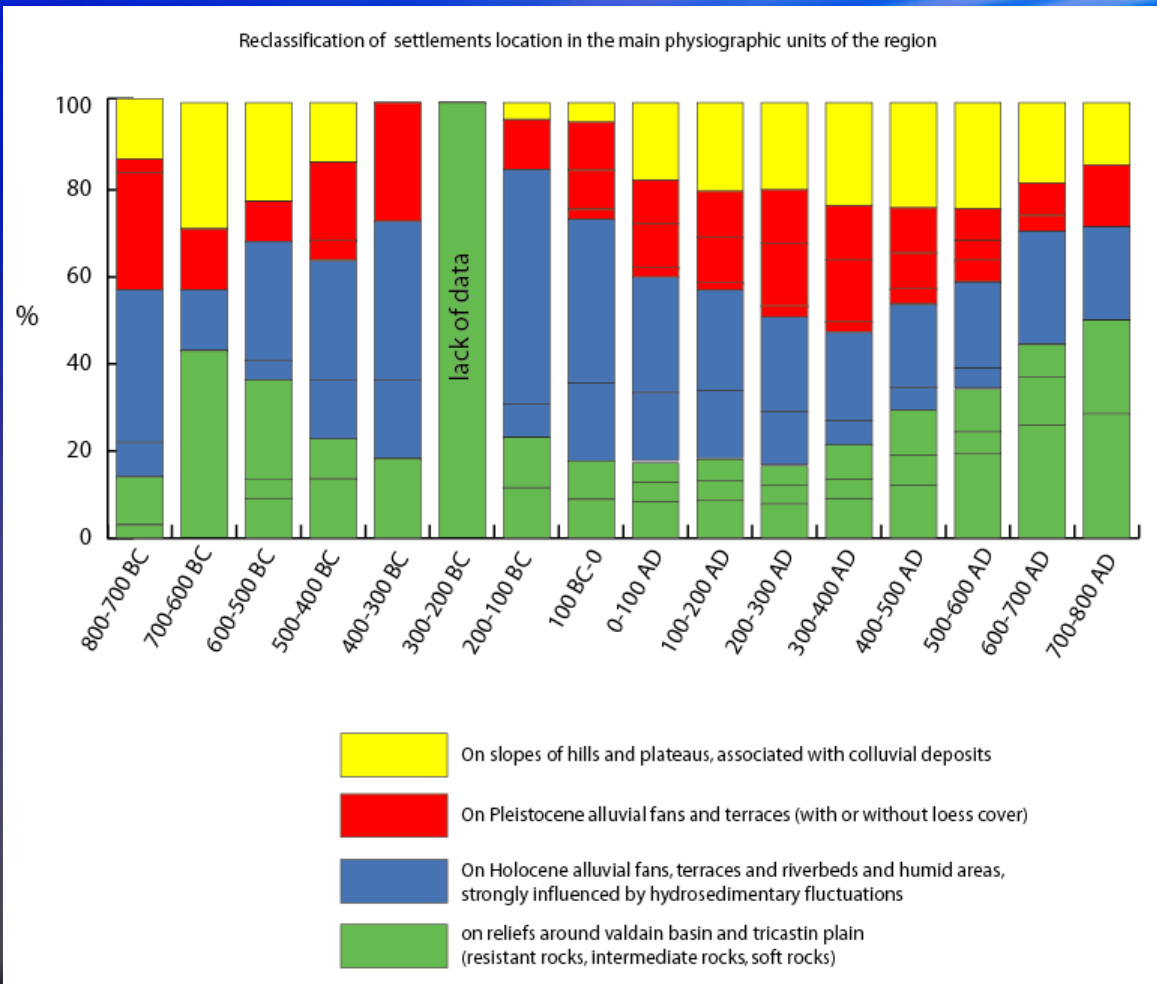
The Roman settlement curve



The Roman settlement of Southern France



Settlement location reflects landscape choice

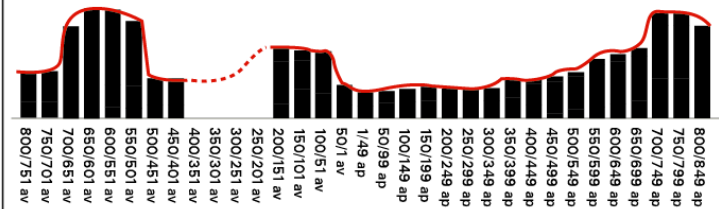


Settlement choices change through time ... but not with the climate!

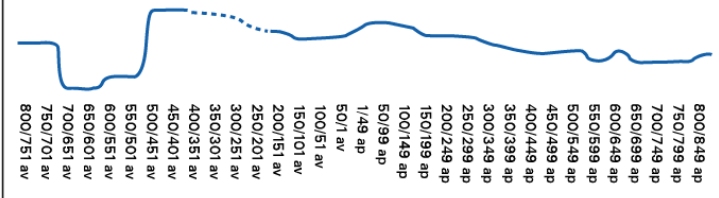
a.

Comparing uplands and lowlands

Agrarian territories : dominant erosion soils around settlements between 800 BC and 800 AD (location in reliefs around the Valdain and Tricastin)

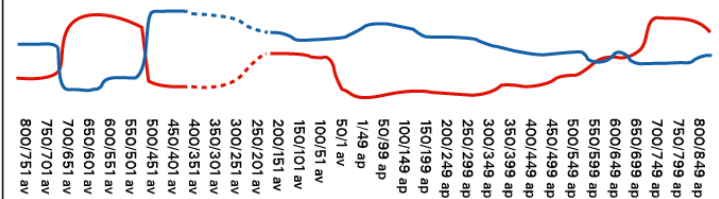


Agrarian territories : dominant fluvial soils around settlements between 800 BC and 800 AD (location in lower plains of the Valdain and Tricastin)



Typological study of the settlement organization

Comparison of curves of erosion soils association and dominant fluvial soils of agrarian territories between 800 BC and 800 AD (anti-correlation)



Negative correlation between the extent of the eroded soils in the highlands and the extent of agricultural lands around settlements in the Valdaine and Tricastin:

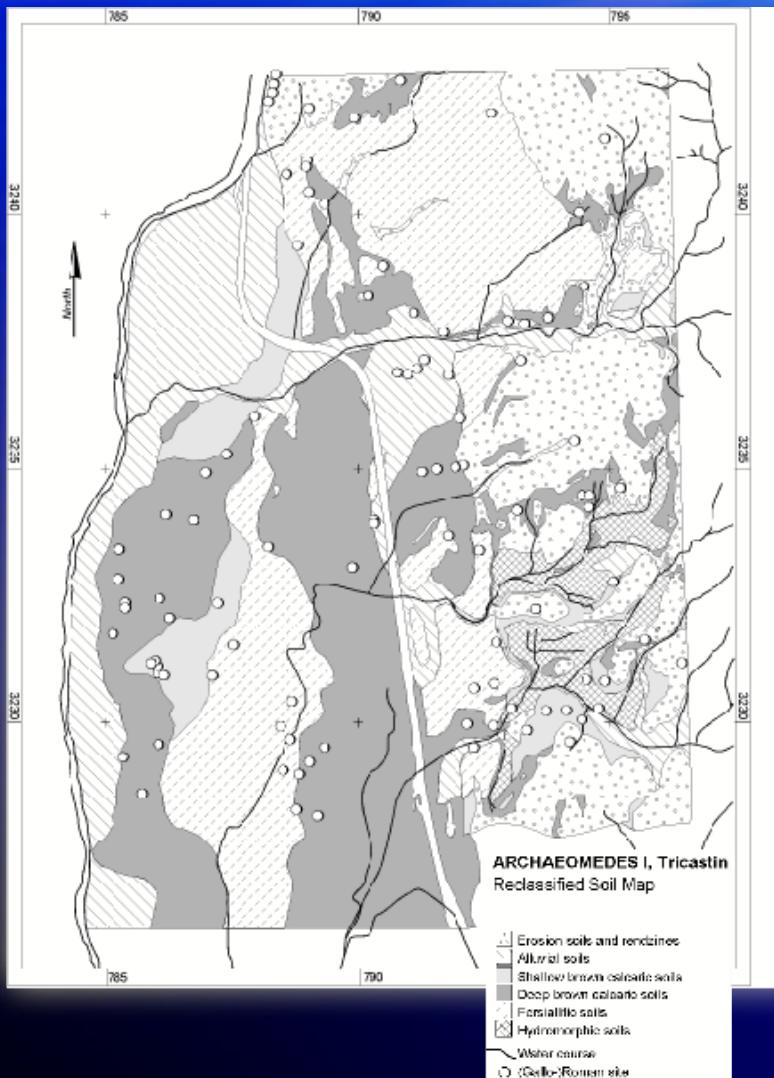
- a. Eroded surfaces in the highlands
- b. Agricultural lands in the lowlands
- c. Comparing the two curves

It is all a matter of perception ...

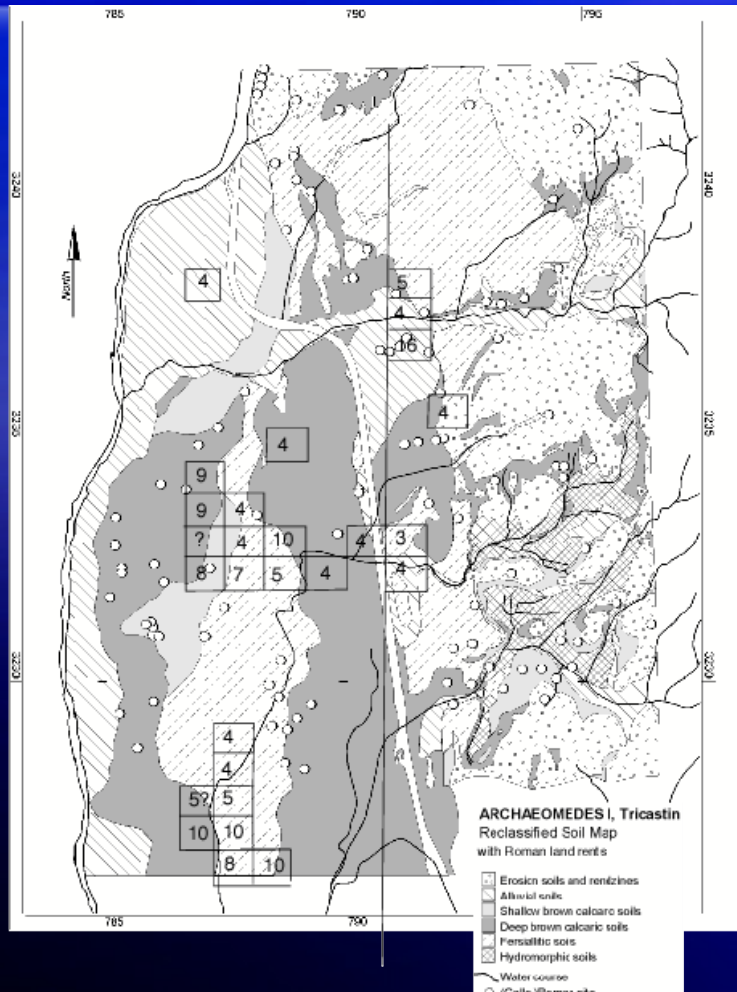
The roman perception of soils was very different from ours

It prefers ease of handling over mineral content : light soils on low slopes preferred over very rich, but heavy, valley bottoms

We had to reinterpret the soil maps!



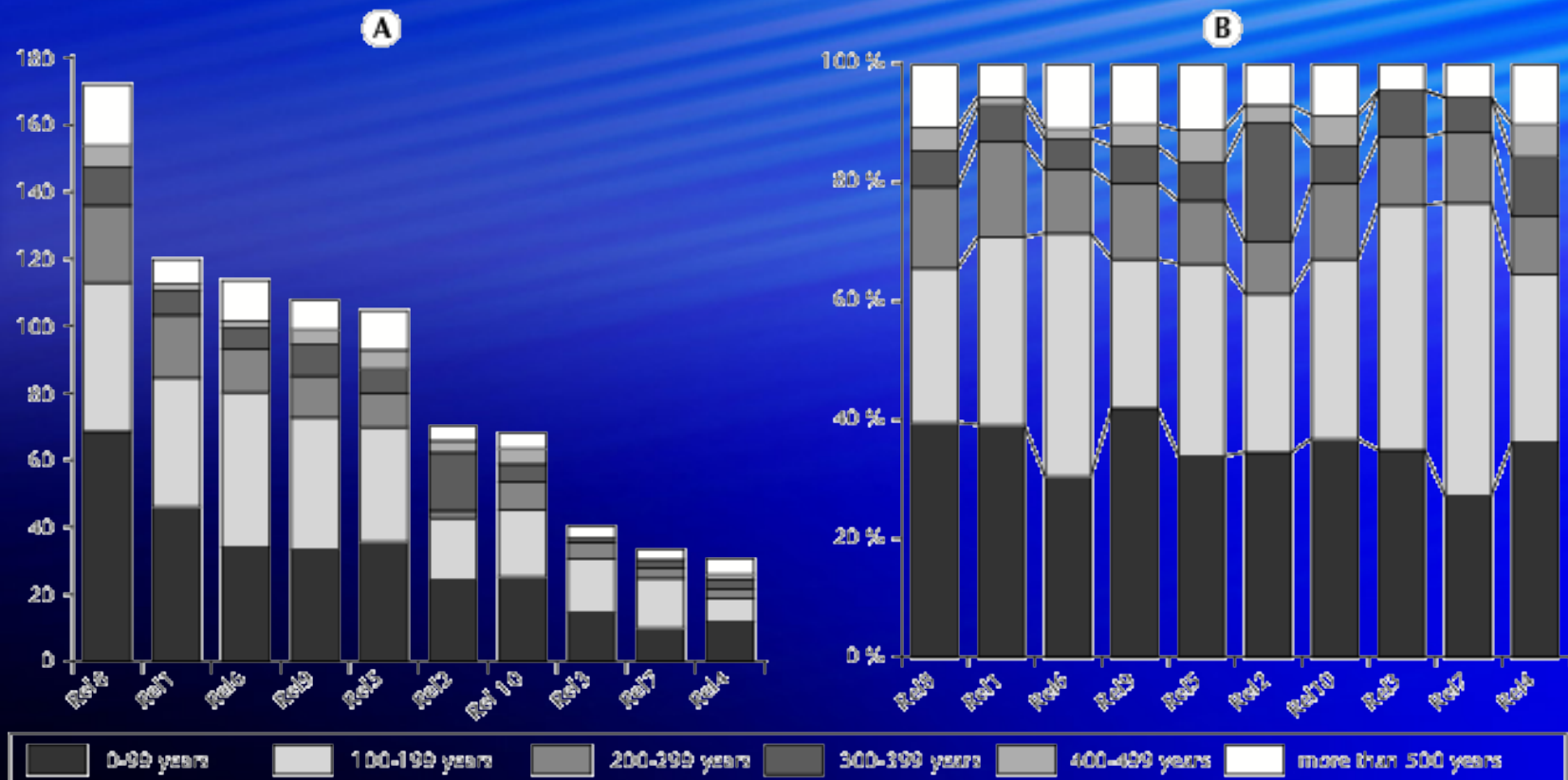
Roman land rents

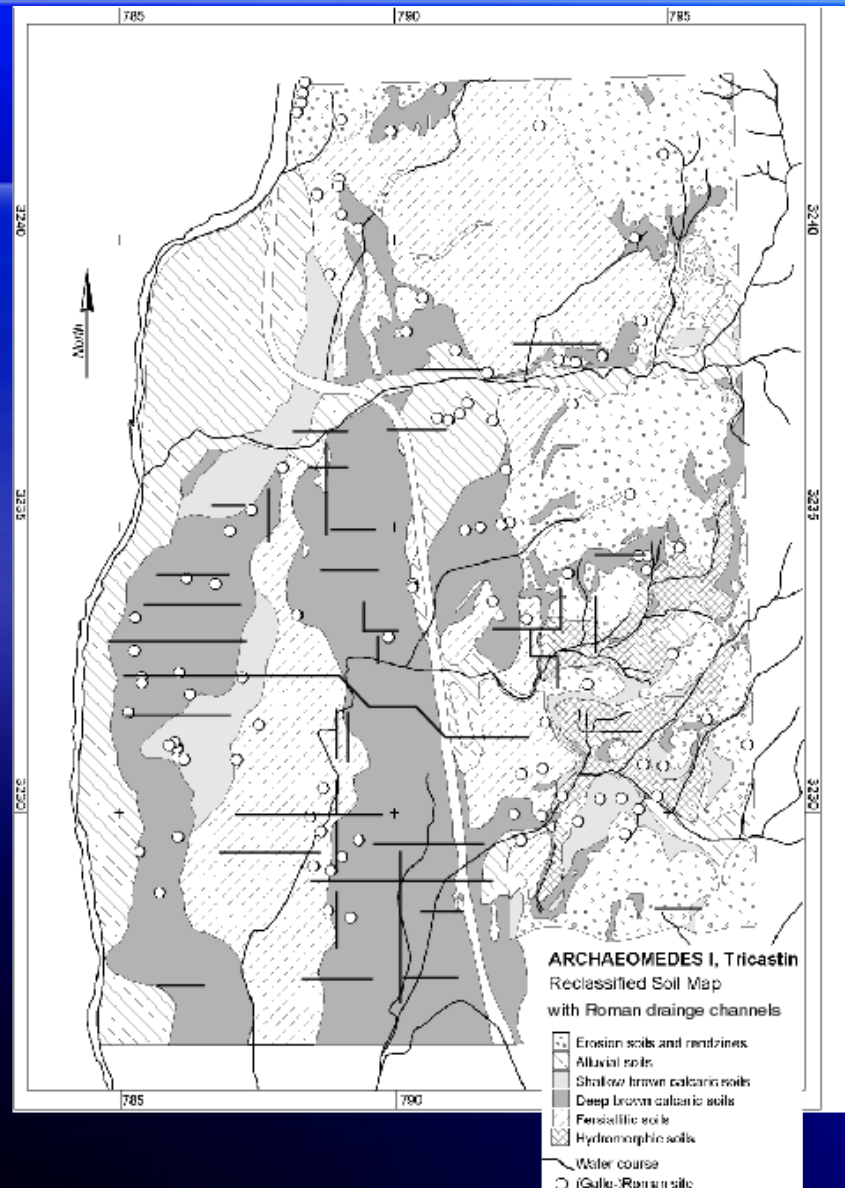


Data are available for the Tricastin area

These taxes, in *asses* per *iugera*, confirm the analysis

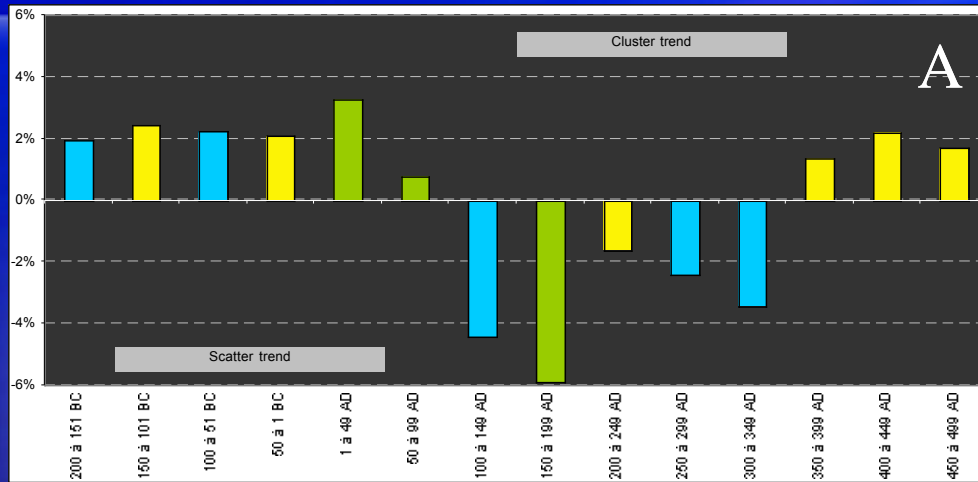
The '2nd-3rd century crisis' is a reorganization driven by the economy





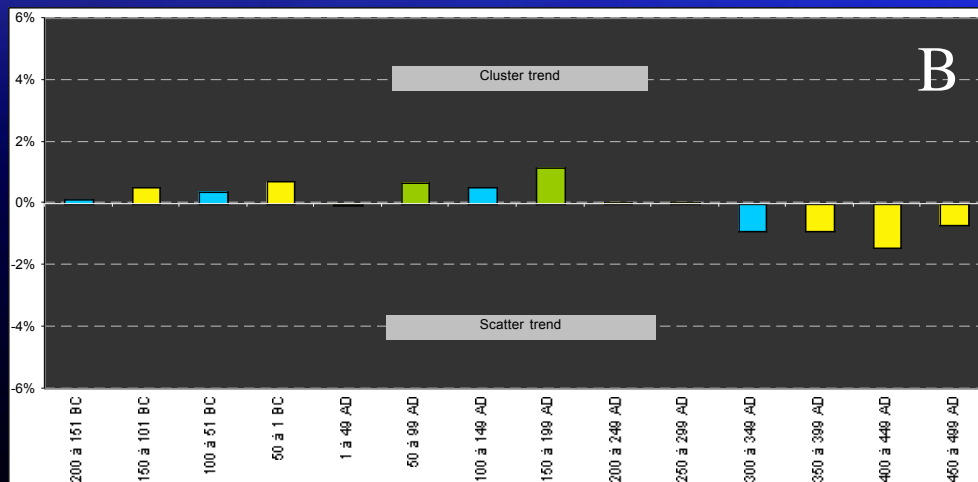
*In the Tricastin,
the 2nd-3rd
century 'crisis' is
a 'peace
dividend'*

Each region reacts differently



A: Tricastin
(densely settled
plain)

B: Valdaine
(mountainous area)



B. Climate:

Green: Mixed

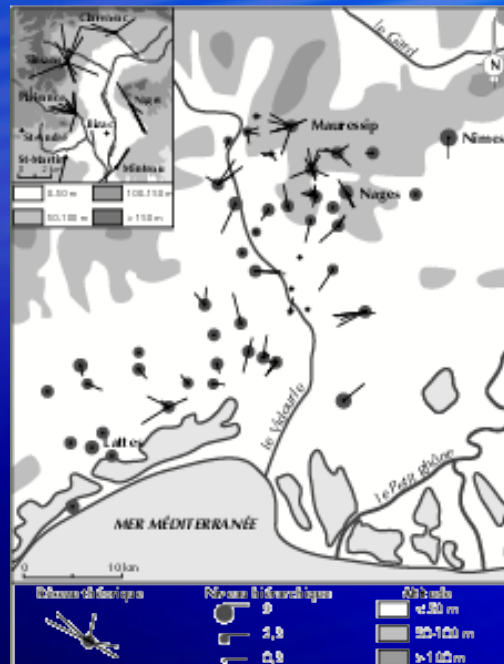
Blue: Unstable

Yellow: Stable

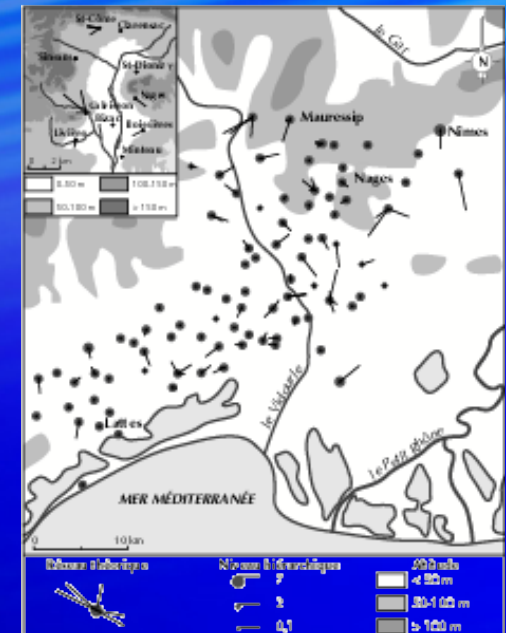
Internal dynamics of the settlement system



1st Cty. AD



5th Cty. AD



11th Cty. AD

Comparing two crises

- 2–3rd century crisis is overcome, 6th century is not ...
- Difference in degree of integration:
 - Before 3rd C. much looser
 - Lower overheads
- 3rd C. transformations create more coherent structure, increases interdependencies, vulnerability
- 6th century crisis:
 - No new areas to conquer, no new riches
 - Very heavy overhead (Imperial structure)
 - No internal flexibility in the system

Conclusion

- In the recent past and present, environmental crises can be triggered by both social and environmental phenomena
- One needs to look at the combined system over the longer term, looking at the 'change of change'
- The new element in recent times is the acceleration of change which cannot be matched by society
- Today the EU released a report that proposes huge investments to adapt to climate change, which will take away from efforts to mitigate it: moving complete cities, etc.
- That is fundamentally the same dilemma as that which caused the Roman Empire to end
- But a few centuries later, it all started over again ...