Intensive monitoring system of stand dynamics of Mediterranean forest ecosystems: From conception to the results

Construção do Modelo Conceptual de O.T.

Pressupostos do Modelo

Construção do Modelo Conceptual

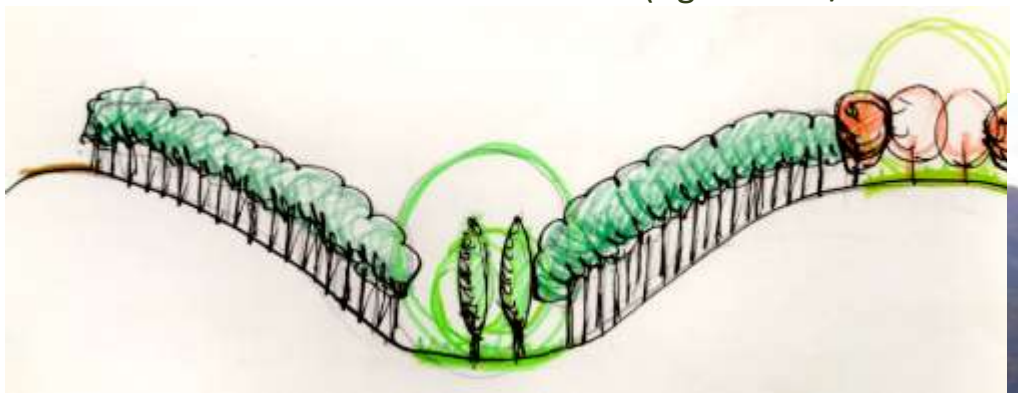
Estrutura da Paisagem Resiliente ao Fogo

ESTRUTURA BÁSICA DO ORDENAMENTO RURAL

ESTRUTURA FUNDAMENTAL DE CONSERVAÇÃO DA PAISAGEM
Estrutura Ecológica/ Infraestrutura Verde
+
ESTRUTURA DE PROTEÇÃO CONTRA O FOGO

COMPARTIMENTOS INTERSTÍCIOS DA ESTRUTURA
(Agricultura/Floresta- Autóctone ou Exótica**)**

Mosaico



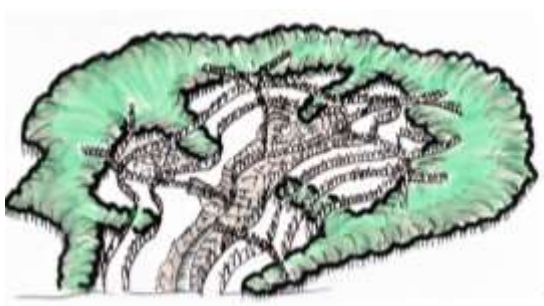
Modelo Conceptual

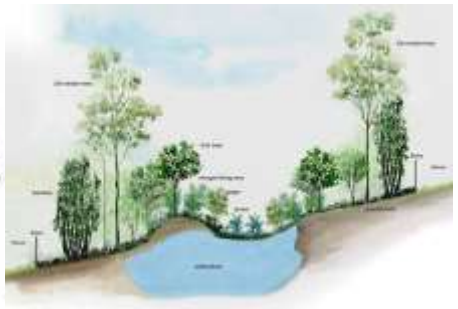
Estrutura da Paisagem Resiliente ao Fogo

Usos retardadores do fogo

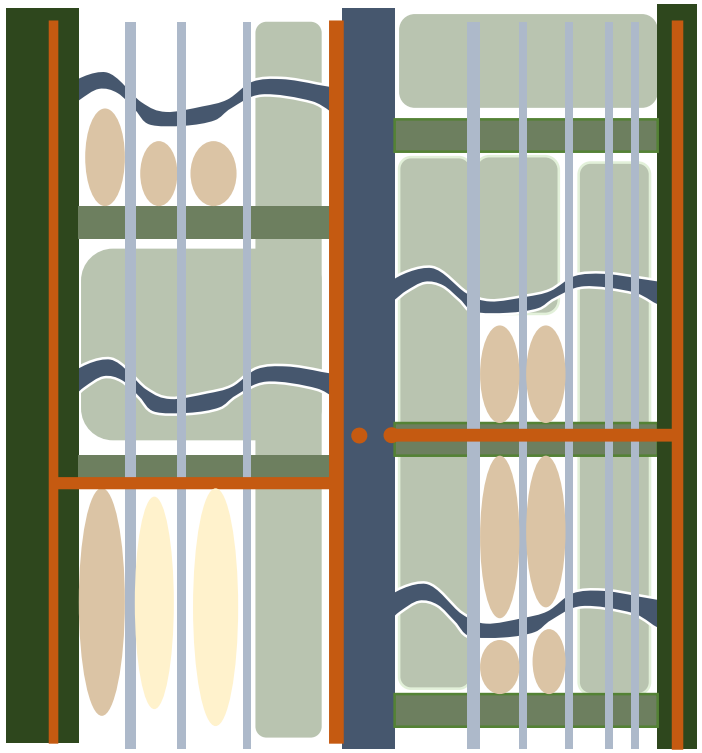
- **Folhosas autóctones ou arqueófitas**
- **Agricultura**
- **Pastagens**
- **valas de infiltração (de nível) com charcas associadas** (técnica da permacultura), revestidas por folhosas

- **Vias** com faixas de protecção
- **Linhas de distribuição de energia** com faixas de protecção
- **Aglomerados** com termo de protecção





Modelo - FIRELAN



Magalhães, M.R.; Cunha, N.S.; Pena, S.B.; Müller, A. FIRELAN—An Ecologically Based Planning Model towards a Fire Resilient and Sustainable Landscape. A Case Study in Center Region of Portugal. Sustainability 2021, 13, 7055. https://doi.org/10.3390/su13137055

Construção do Modelo SIG

Sistema	Sub-sistema		ESTRUTURA DA PAISAGEM RESILIENTE AO FOGO	USOS POTENCIAIS
Físico/ Morfológico	Água	Elementos lineares	Linhas de água e massas de água	Galeria ripícola (*Alnus* sp, *Salix* sp., *Populus* sp, *Fraxinus* sp,)
			Fundos de Vale	Agricultura, pastagemou mata ribeirinha
			Cabeceiras das linhas de água	Mata mistade folhosasautóctones (*Quercus* sp.), arqueófitas (*Castanea sativa*, etc.) e cupressáceas
			Linhas de festo	folhosasautóctones/arqueófitas e prados permanentes(ou agricultura)
			Cabeços largos	
			Valas de Infiltração (swales), lagos	Sistema devala-cômoro ao longo da curva com alinhamentode folhosasautóctones/arquófitas
	Solo		Solos de Elevado valorecológico	Agricultura e/ou pastagem
			Áreas declivosas (>25%)	Folhosas autóctones/arqueófitas ou matos (agricultura e pastagem apenas em terraços)
Biológico	Biodiversidade	Áreas	Vegetação natural e semi-natural com interesse paraconservação (existente)	Conservação e promoção da regeneração natural
			Natura 2000	
			Regeneração natural de espécies autóctones	
Cultural	Agricultura		Agricultura | Pastagem | SistemasAgro-florestais existentes	Conservação e valorização
		Elementos lineares	Sebes de compartimentação	
	Aglomerados		Faixa de proteção aos aglomerados rurais	Agricultura, pastagens, folhosas autóctones/arqueófitas
	Infraestruturas		Faixa de proteção à rede viária	Prados ou folhosas autóctones/arqueófitas
			Faixa de proteção à rede elétrica	Agricultura (pomares baixos), prados, matos baixos autóctones

Componente da Estrutura Ecológica

Componente da Estrutura Ecológica | Cobertura/Uso do Solo existente

Componente da Estrutura Ecológica delimitada em escalas de maior detalhe

Construção do Modelo SIG

Sistema	Sub-sistema		ESTRUTURA DA PAISAGEM RESILIENTE AO FOGO	USOS POTENCIAIS
Físico/ Morfológico	Água	Elementos lineares	Linhas de água e massas de água	Galeria ripícola (*Alnus* sp, *Salix* sp., *Populus* sp, *Fraxinus* sp,)
			Fundos de Vale	Agricultura, pastagem ou mata ribeirinha
			Cabeceiras das linhas de água	Mata mista de folhosas autóctones (*Quercus* sp.), arqueófitas (*Castanea sativa*, etc.) e cupressáceas
			Linhas de festo	folhosas autóctones/arqueófitas e prados permanentes (ou agricultura)
			Cabeços largos	
			Valas de Infiltração (swales), lagos	Sistema de vala-cômoro ao longo da curva com alinhamento de folhosas autóctones/arquófitas
	Solo	Áreas	Solos de Elevado valor ecológico	Agricultura e/ou pastagem
			Áreas declivosas (>25%)	Folhosas autóctones/arqueófitas ou matos (agricultura e pastagem apenas em terraços)
Biológico	Biodiversidade		Vegetação natural e semi-natural com interesse para conservação (existente)	Conservação e promoção da regeneração natural
			Natura 2000	
			Regeneração natural de espécies autóctones	
Cultural	Agricultura		Agricultura | Pastagem | Sistemas agro-florestais existentes	Conservação e valorização
		Elementos lineares	Sebes de compartimentação	
	Aglomerados		Faixa de proteção aos aglomerados rurais	Agricultura, pastagens, folhosas autóctones/arqueófitas
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			Faixa de proteção à rede elétrica	Agricultura (pomares baixos), prados, matos baixos autóctones

Componente da Estrutura Ecológica

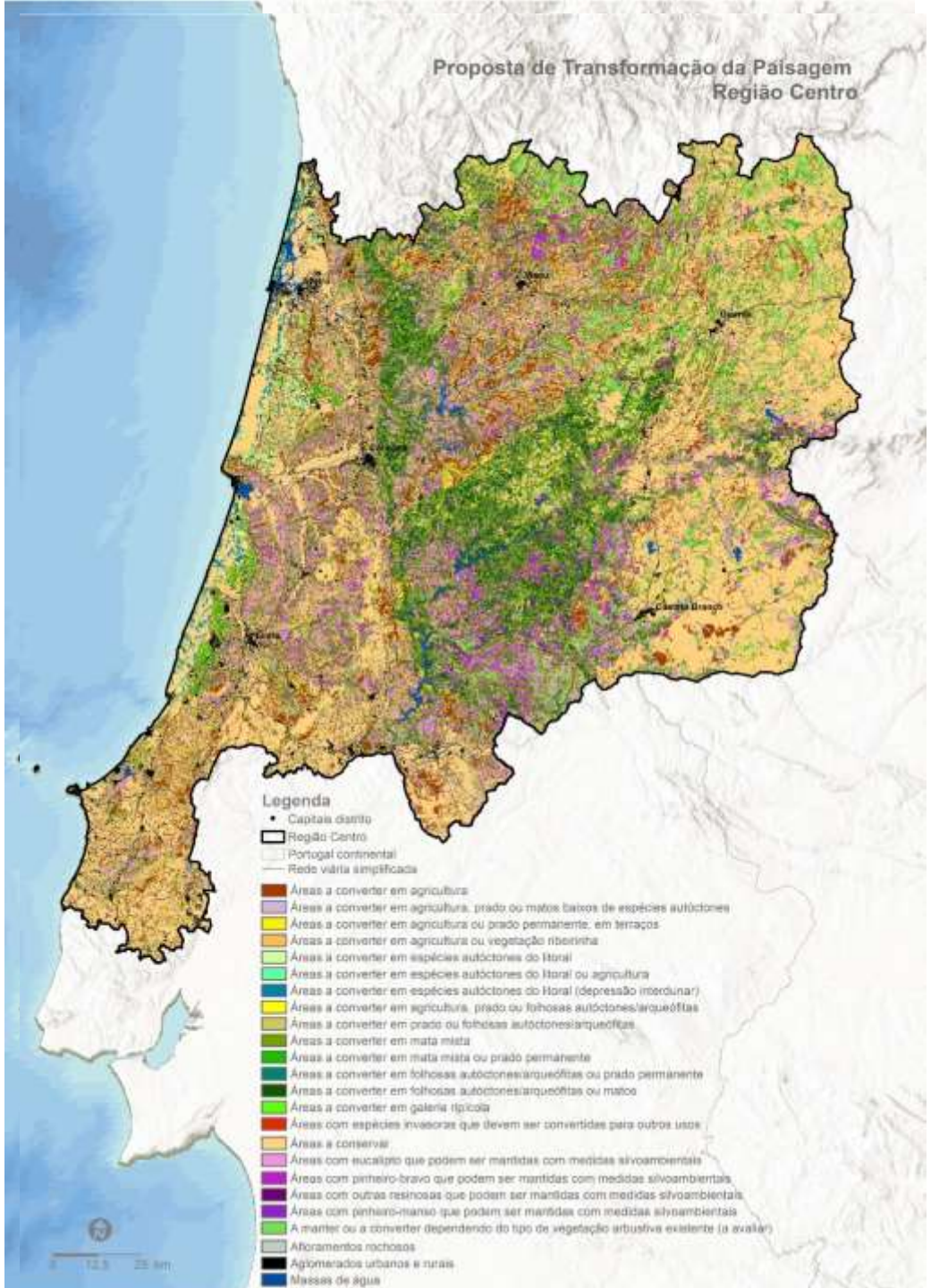
Componente da Estrutura Ecológica | Cobertura/Uso do Solo existente

Componente da Estrutura Ecológica delimitada em escalas de maior detalhe

Construção do Modelo SIG

Áreas complementares (fora da estrutura) – vários usos possíveis (agricultura, floresta de corte de fruto, etc..)

Aplicação do Modelo de O.T aos diferentes casos de estudo



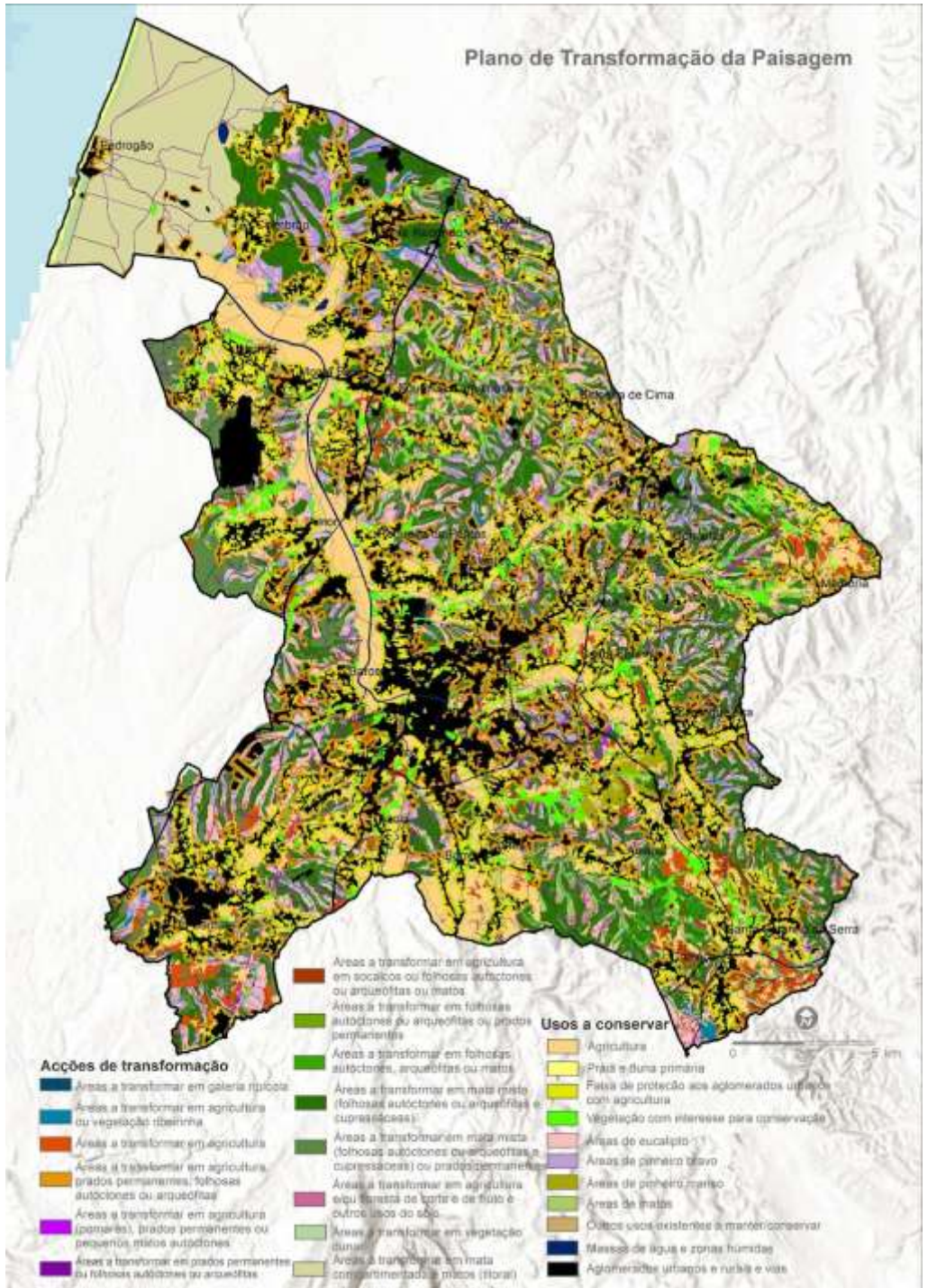
Região Centro

Estrutura FIRELAN

Usos do Solo Potenciais

Plano de Transformação da Paisagem

- 35% a transformar
- A agricultura poderia aumentar de 23% para 35%
- As espécies autóctones podem ser expandidas em 31%
- O eucalipto, que, no total, ocupa 17% da região, devia ser reduzido para 5%, apenas em áreas complementares



Leiria

Estrutura FIRELAN

Usos do Solo Potenciais

Plano de Transformação da Paisagem

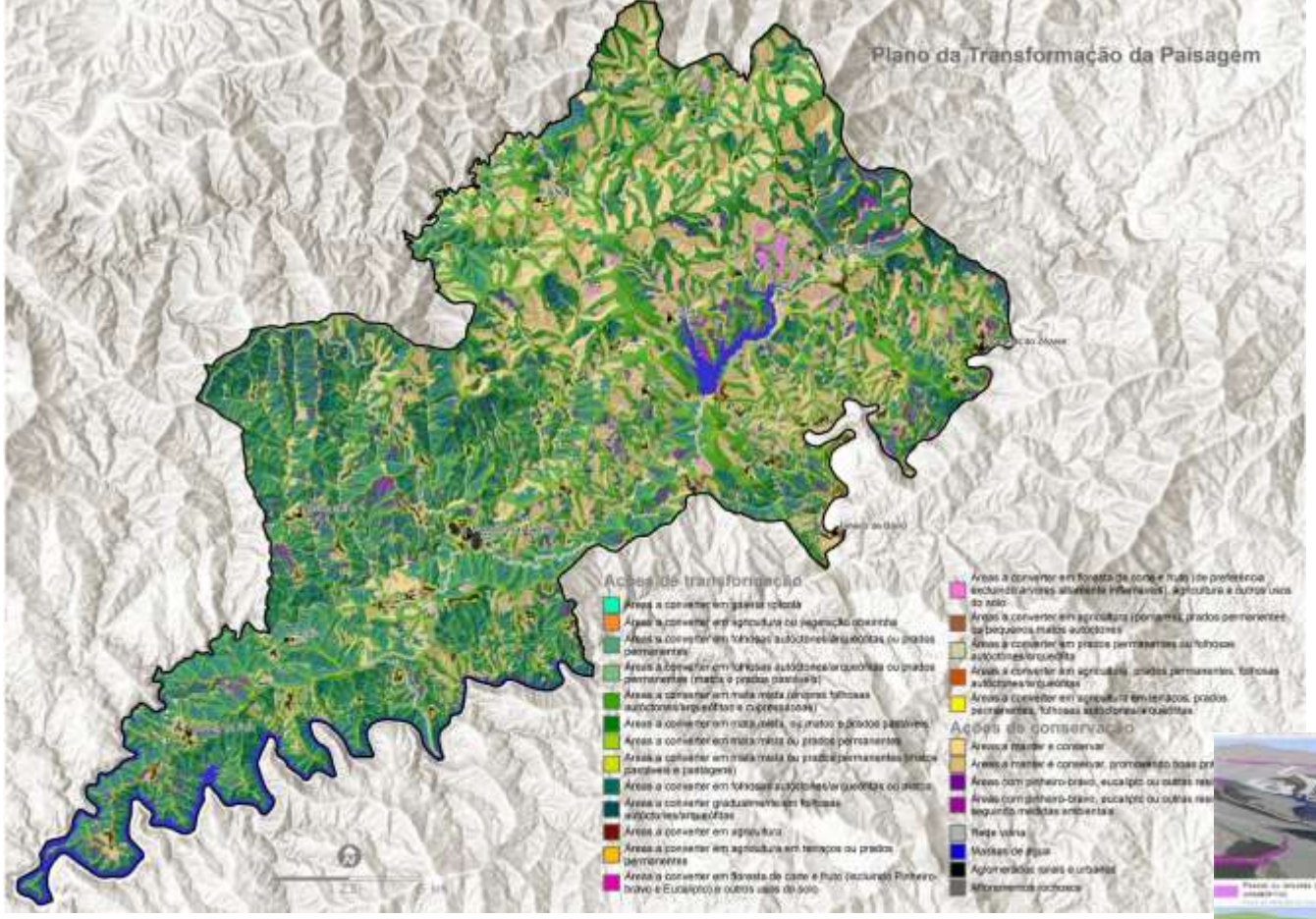
- 45% a transformar
- Cabeceiras das linhas de água (mata mista), 13,8%; e faixas aos aglomerados (agricultura) 10,8% da área do concelho
- 1,7% do território - conversão para galeria ripícola
- A área de eucalipto e pinheiro a manter deveria ser 10% do território (e não 53%)

Pampilhosa da Serra

Estrutura FIRELAN

Usos do Solo Potenciais

Plano de Transformação da Paisagem



- 67,8% são usos a transformar
- 19,4% são áreas declivosas com usos desadequados (pinheiro bravo e eucalipto)
- 5% do território tem linhas de água ocupadas por Pb, Ec ou matos – necessidade de restauro das linhas de água
- Importância dos matos na conservação do solo e da água
- Baldios (solos de baixo valor ecológico em terras altas - conservação de práticas associadas ao pastoreio)

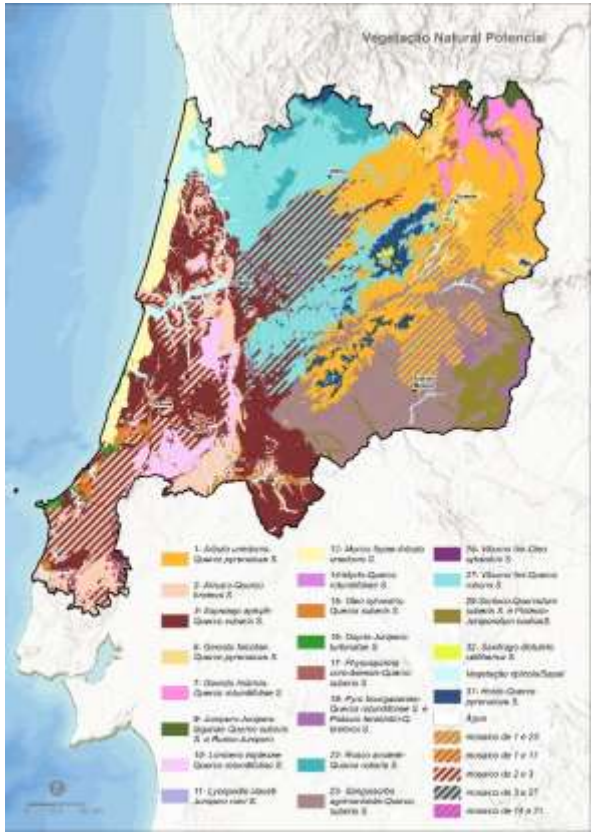
Transformação da Paisagem Rural
Que espécies?

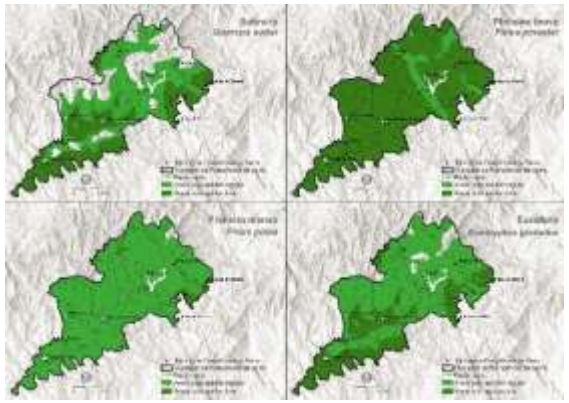
Séries de Vegetação Natural Potencial
diferentes etapas de substituição até ser atingida a etapa climácica, conjunto de espécies (herbáceas/arbustivas/arbóreas) para um tipo de bioclima e tipo de solo

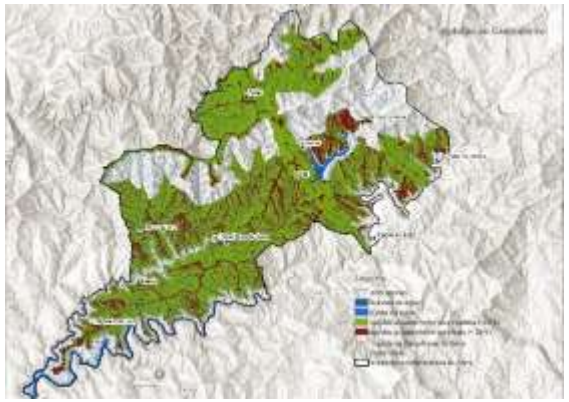
Aptidão produtiva a diferentes espécies

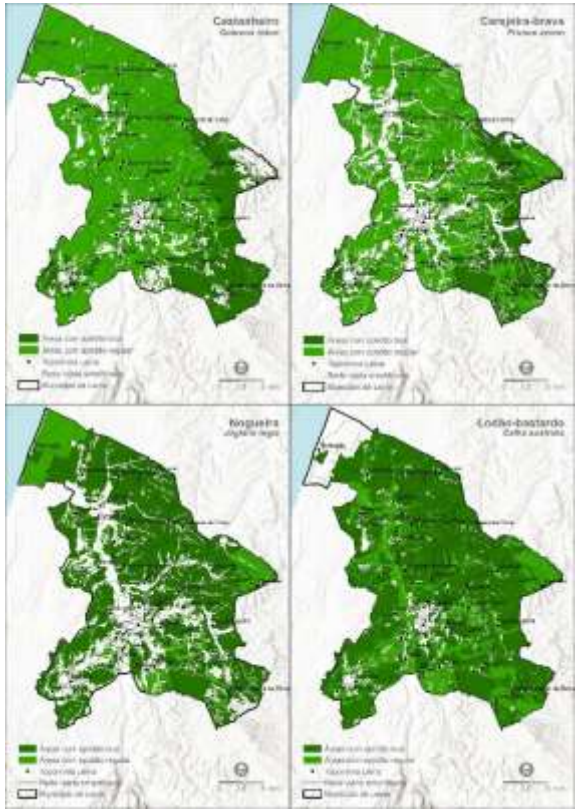
Carvalhos, Nogueira, Castanheiro (fruto e Madeira), Cerejeira, Medronheiro, Pinheiro, etc

Modelos de Silvicultura Próxima da Natureza





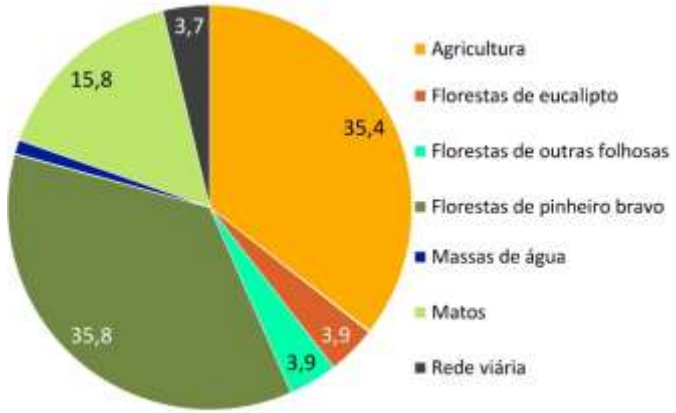




O “termo” das aldeias

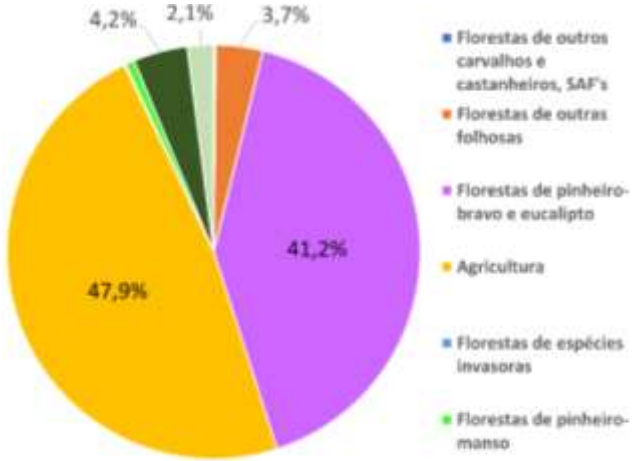
Pampilhosa da Serra

Apenas 35% das faixas de proteção aos aglomerados urbanos encontra-se ocupada com agricultura, 36% com Pinheiro bravo, 16% por matos



Leiria

48% das faixas de proteção aos aglomerados urbanos encontra-se ocupada com agricultura, 41% por pinheiro bravo/eucalipto



Research in forest sciences
Problem/solve approach

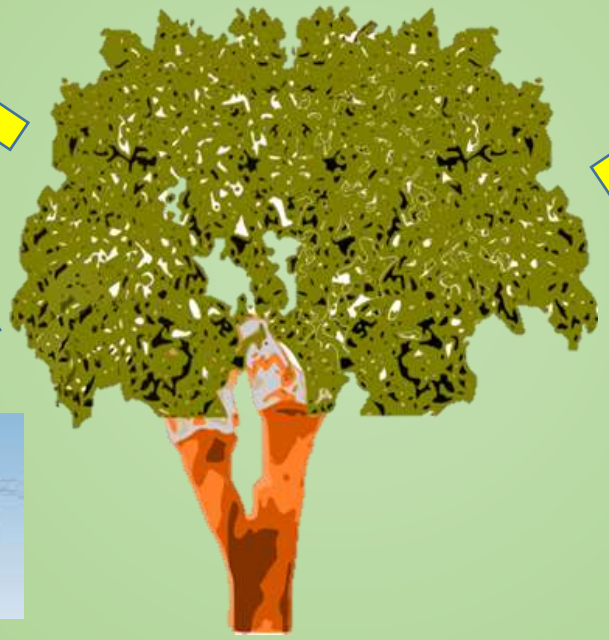
Diachronic/syncronic remote sensing research

Precision silvicultural models

Model devellopment:

-Spatial statistic models

-Functional structural models



3D research:

All tree

Stand

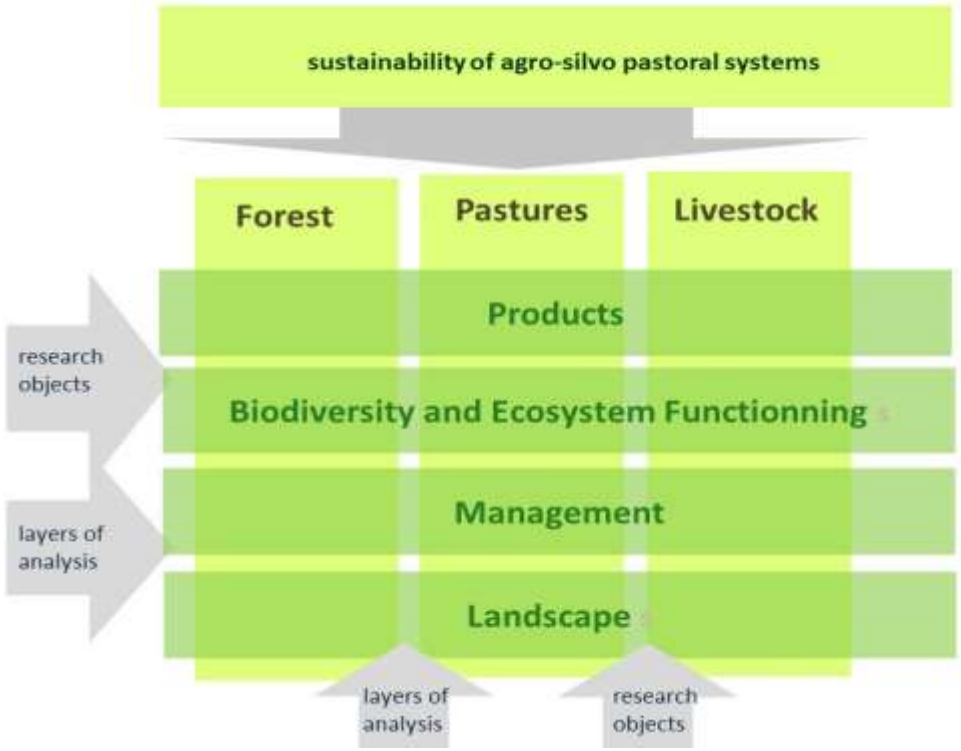
Adaptive management

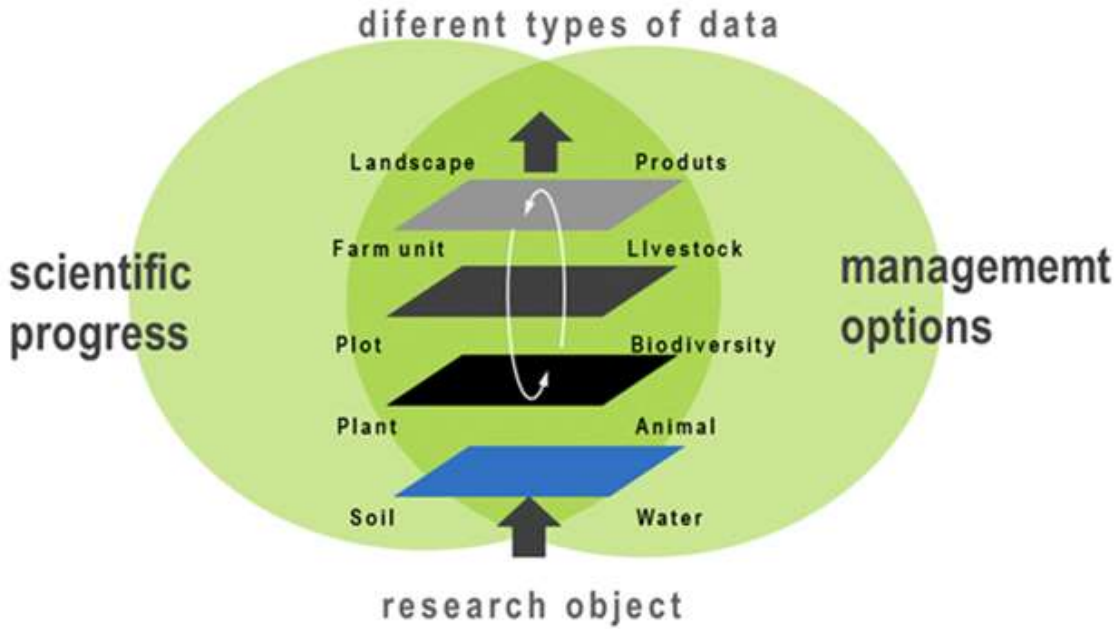
EcoDendro team

Growth modelling from statistic to functional structural models.

Sustainable management of Mediterranean forest systems

Research structure





The research is structured on the required components for the agro-silvo pastoral system to be classified as such: forest, pastures, and livestock. It includes the interactions between these components, and other, integrative dimensions. At each layer of analysis different research questions are addressed, defining a particular research object. All questions have as their ultimate goal, the production of knowledge contributing to a higher sustainability of the whole system.

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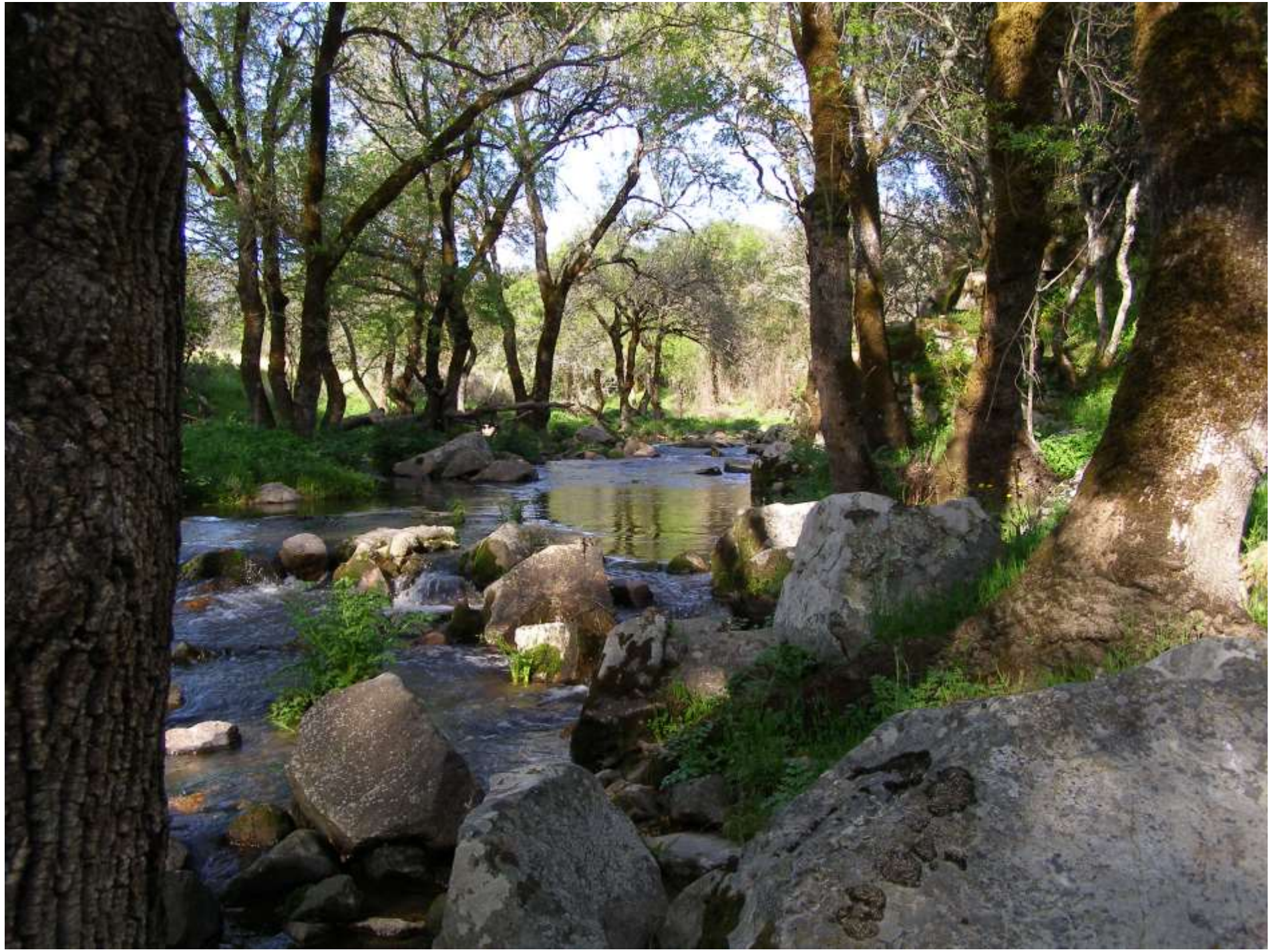
Forest managment
Microestruture
Macroestruture
Externalities

Riparian zone of Suwannee Creek, Sequoia-Kings Canyon National Park, California.

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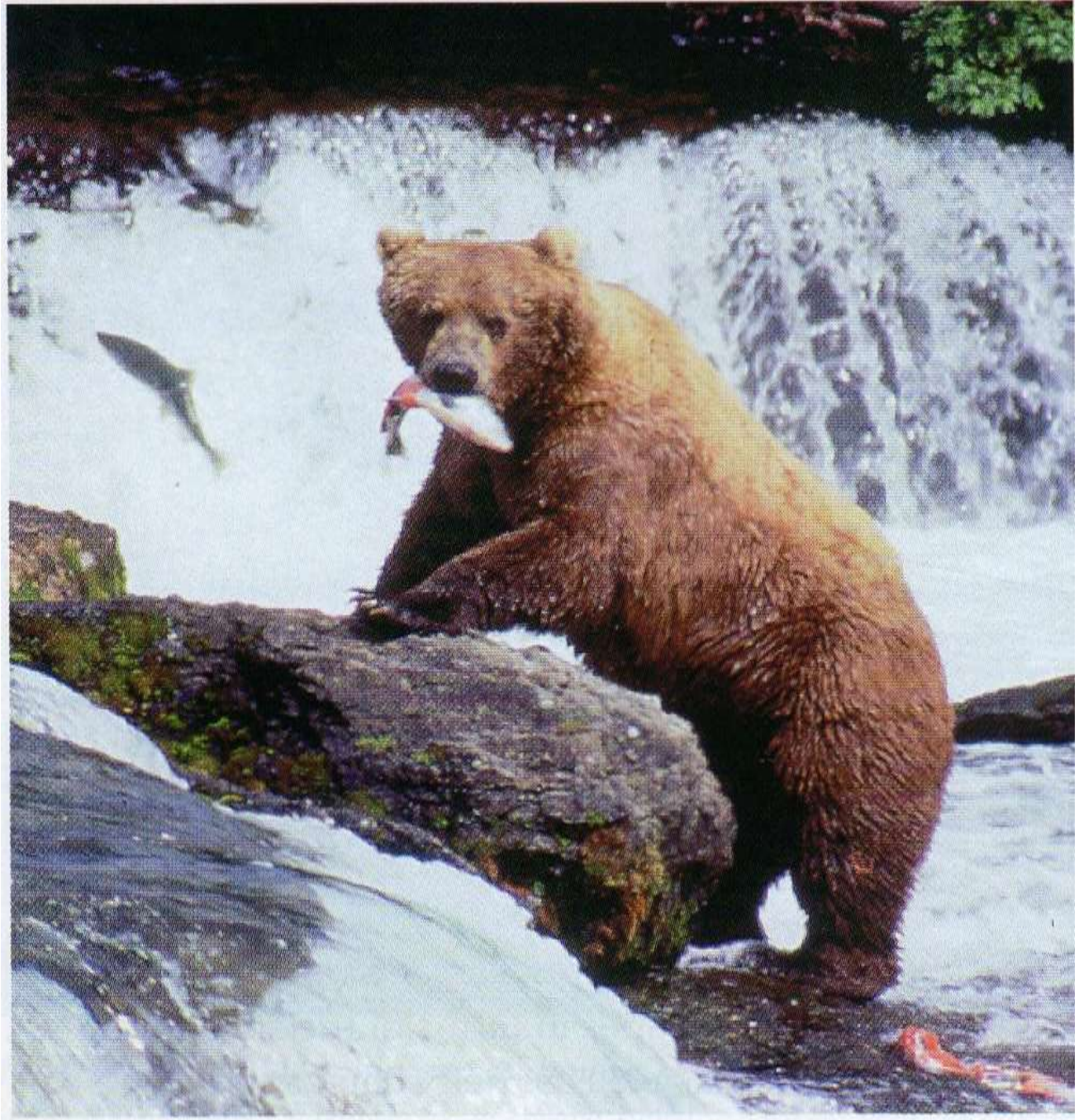
Logs (including root wads) along Queets River, Olympic National Park, Washington.



Brown bear and salmon, Katmai National Park, Alaska.

Goods and services produced by forests

Goods and services with market
• Wood, Cork
• Acorn
• Animals (cows, sheep, pigs)
• Mushrooms
• Number of regenerating plants
• Carbon sequestration
Biodiversity
• Animal biodiversity
• Vegetation biodiversity
• Ecossystem quality
Site resources preservation
• Erosion risk
• Water retention
• Soil organic matter content
• Fire risk index

Características dos sistemas florestais:
Os ecossistemas florestais sistemas com multiplas variáveis de "output"

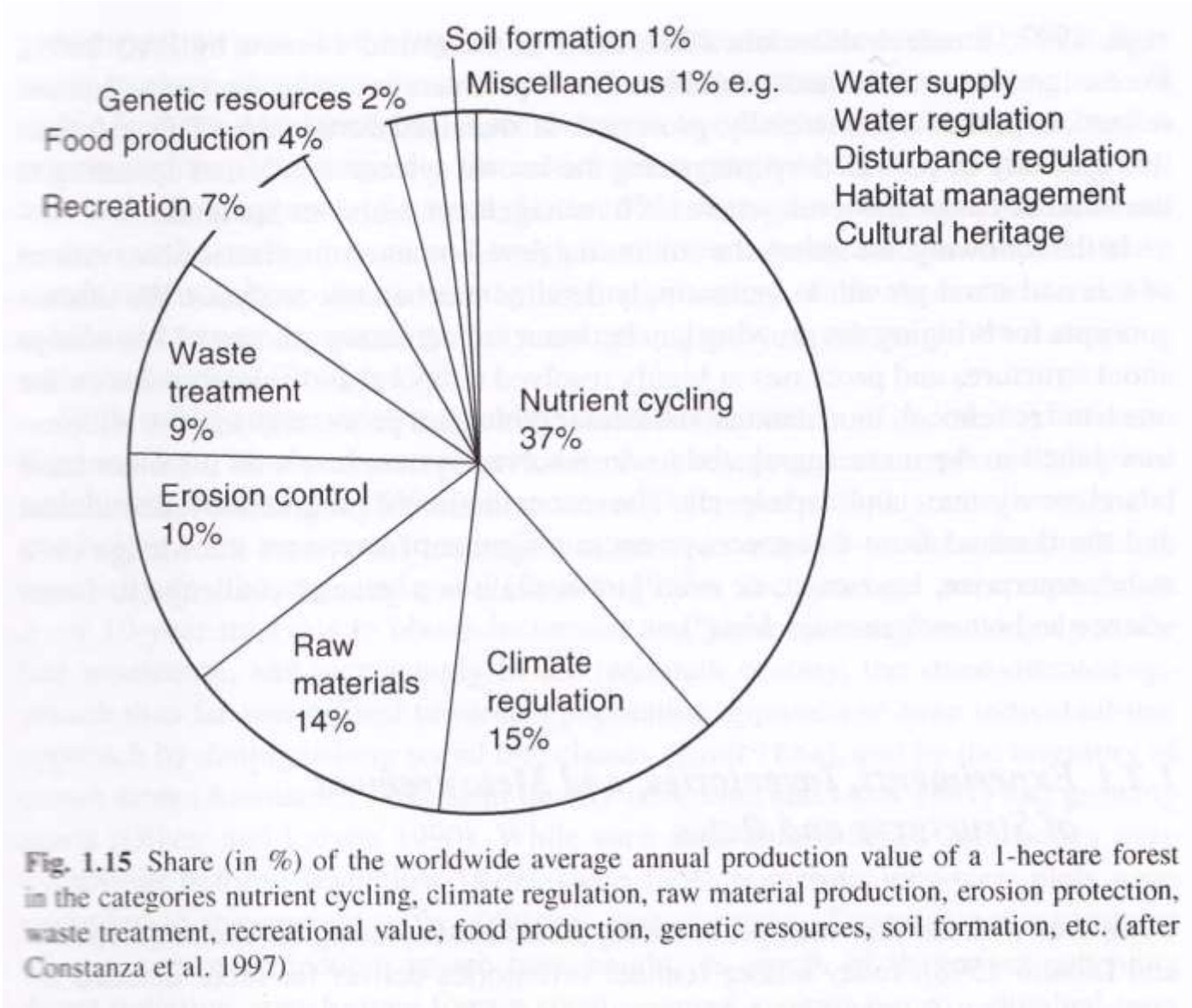


Fig. 1.15 Share (in %) of the worldwide average annual production value of a 1-hectare forest in the categories nutrient cycling, climate regulation, raw material production, erosion protection, waste treatment, recreational value, food production, genetic resources, soil formation, etc. (after Constanza et al. 1997)

Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

Characteristics of forest systems

Characteristics of forest systems: Time scale

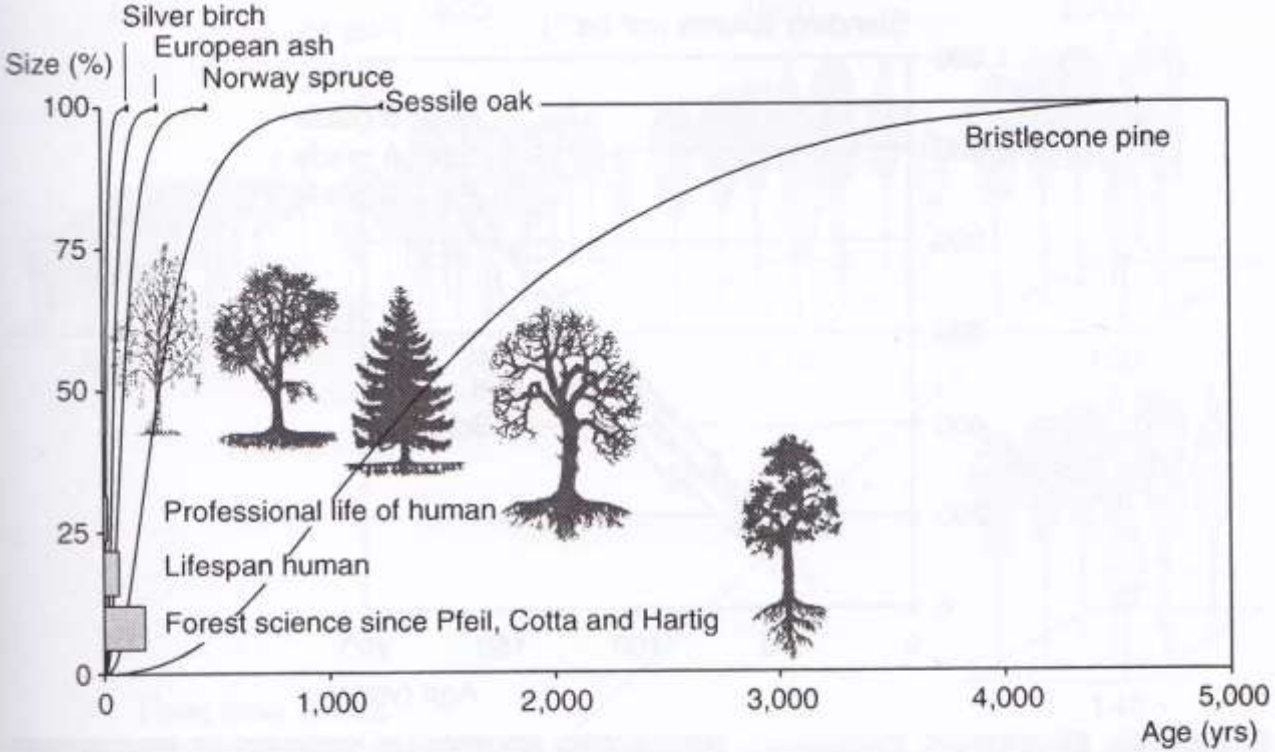


Fig. 1.1 The life span of humans and trees differ by up to two orders of magnitude. The relative size development of individual trees by age is shown for Silver birch (*Betula pendula* Roth), European ash (*Fraxinus excelsior* L.), Norway spruce [*Picea abies* (L.) Karst.], Sessile oak [*Quercus petraea* (Matuschka) Liebl.] and Bristlecone pine (*Pinus aristata* Engelm.). The time bars in the lower part of the graphic point out the superior lifetime of trees are compared to the research time and lifetime of a human, and the entire history of (modern) forest science since its foundation through W. L. Pfeil (1783–1859), H. Cotta (1763–1844), and G. L. Hartig (1764–1837) in the late eighteenth century

Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

Characteristics of forest systems: Time scale

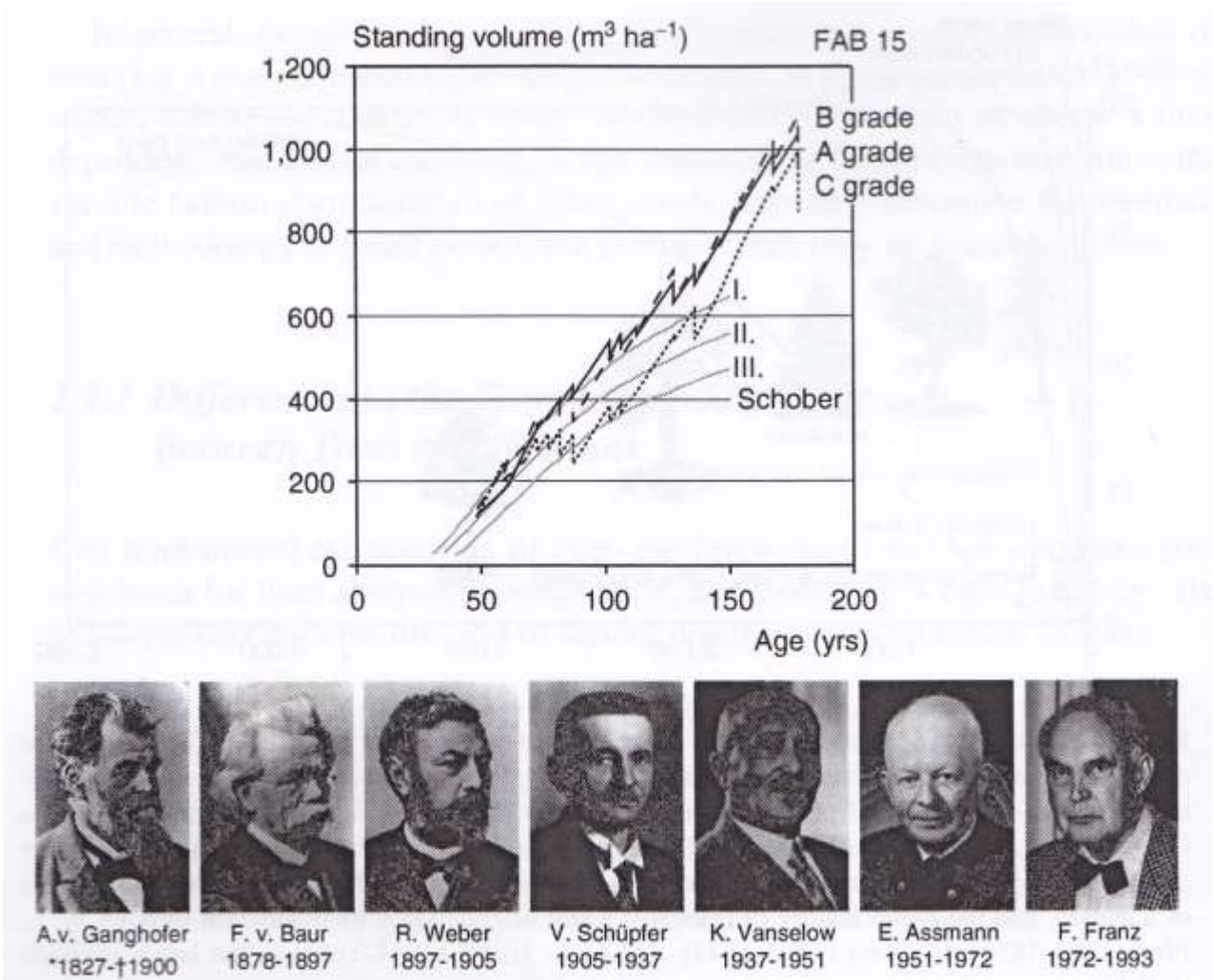


Fig. 1.2 Long-living organisms require long-term research. Development of standing volumes (m^3 ha^{-1}) on the European beech thinning experiment Fabrikschleichach 15 (A, B, and C grade) (*above*) as the result of transgeneration measurements of the forest yield research in Munich (*below*). As one of more than hundred long-term experimental plots in Bavaria, the Fabrikschleichach plots have been surveyed regularly for 130 years

Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

Characteristics of forest systems: Time scale

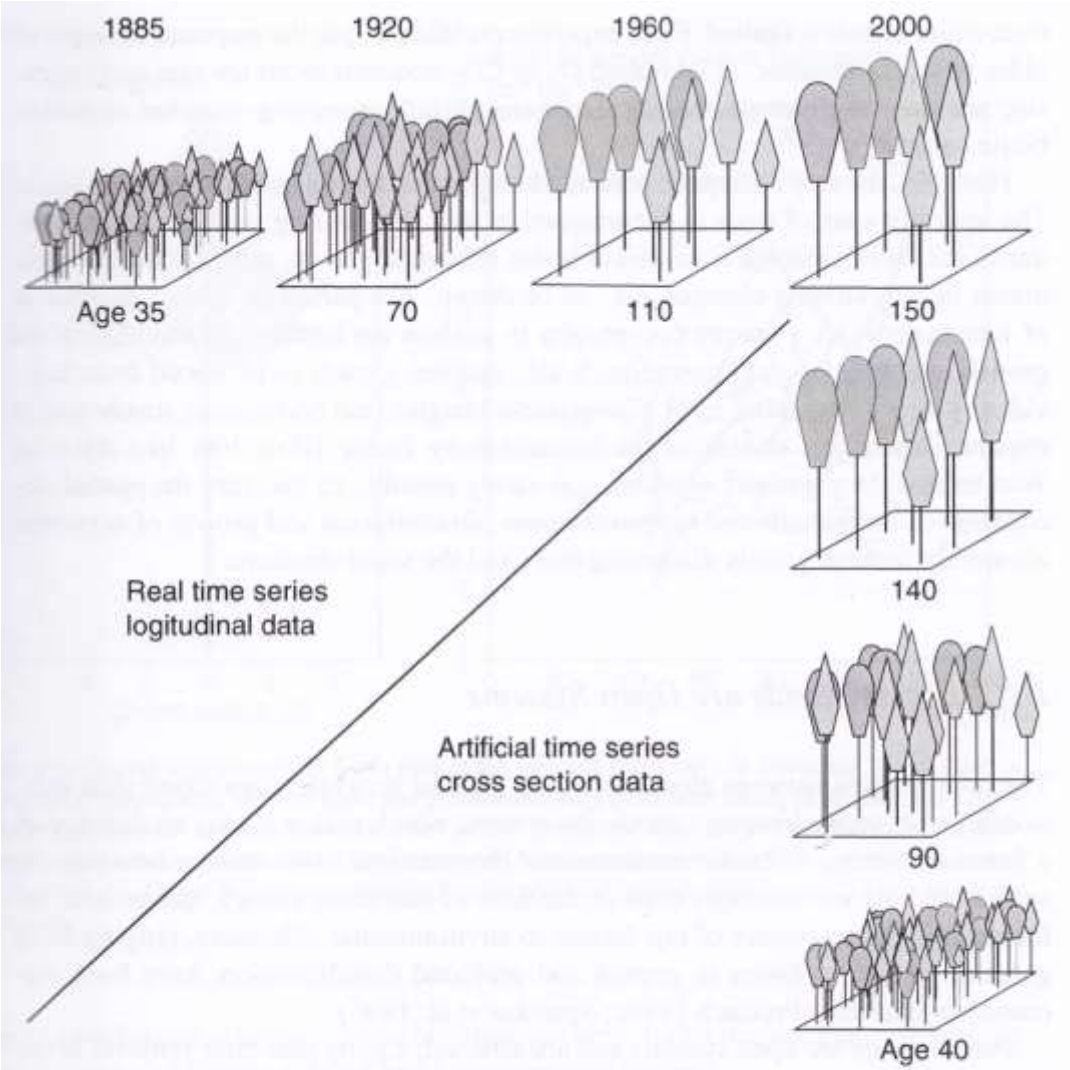


Fig. 1.3 Comparison of the principles of real time series and artificial time series. If stand development is recorded regularly from 1885 to 2000, then the sequence of data produces a real time series with surveys in 1885, 1920, 1960, and 2000 (*row*). In contrast, an artificial time series is constructed from spatially adjacent stands in different development phases (e.g. age 40, 90, 140, and 150) with comparable site conditions (*column*)

Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

Characteristics of forest systems: Forests are open systems

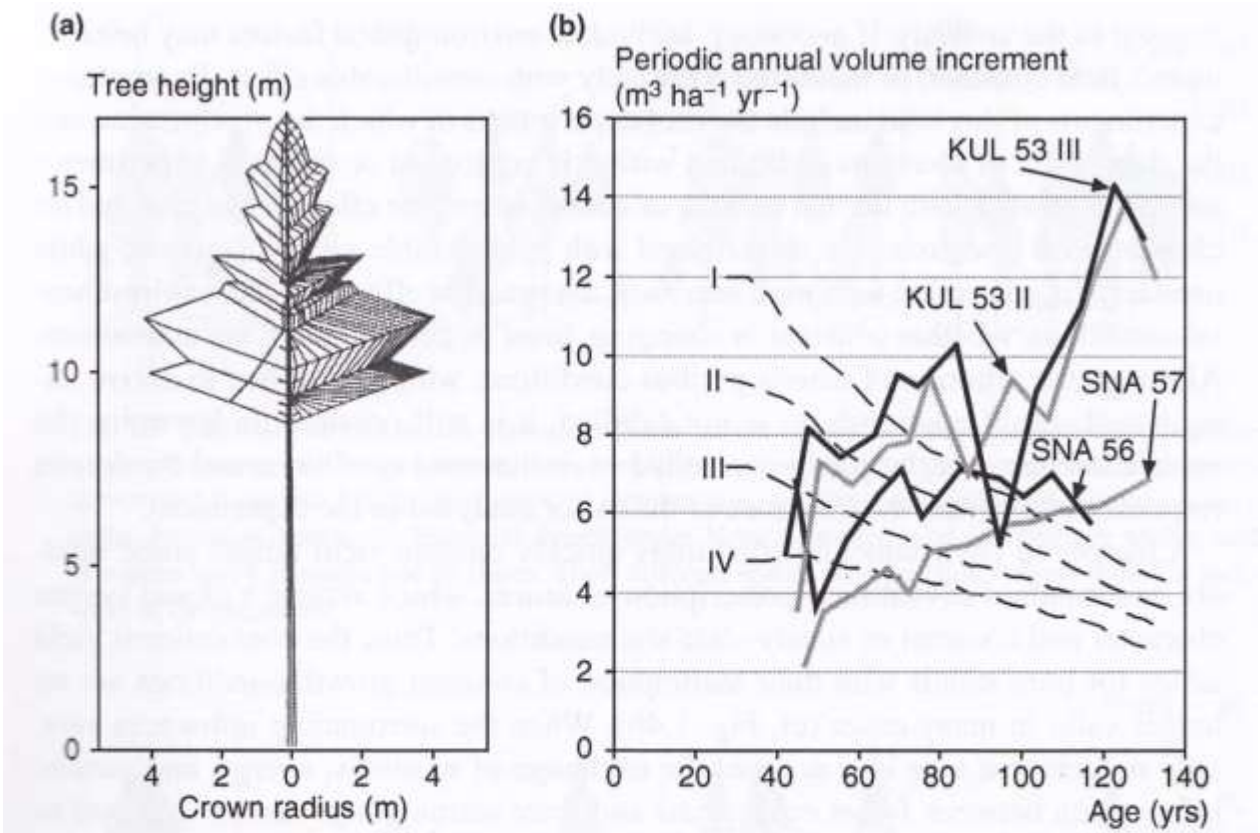


Fig. 1.4 Growth acceleration of Scots pine at the tree and stand level in Northeast Bavaria due to increasing atmospheric nutrient input and gradual recovery from litter raking in the past. (**a**) Crown shape development of Scots pine at Forest District Burglengenfeld, Upper Palatinate and (**b**) periodic annual volume growth on the long-term plots Schnaittenbach 56 and 57, Upper Palatinate and Kulmbach 53, Upper Franconia, compared to the yield table from Wiedemann (1943), moderate thinning

Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

Characteristics of forest systems:
Forests are strongly structured systems

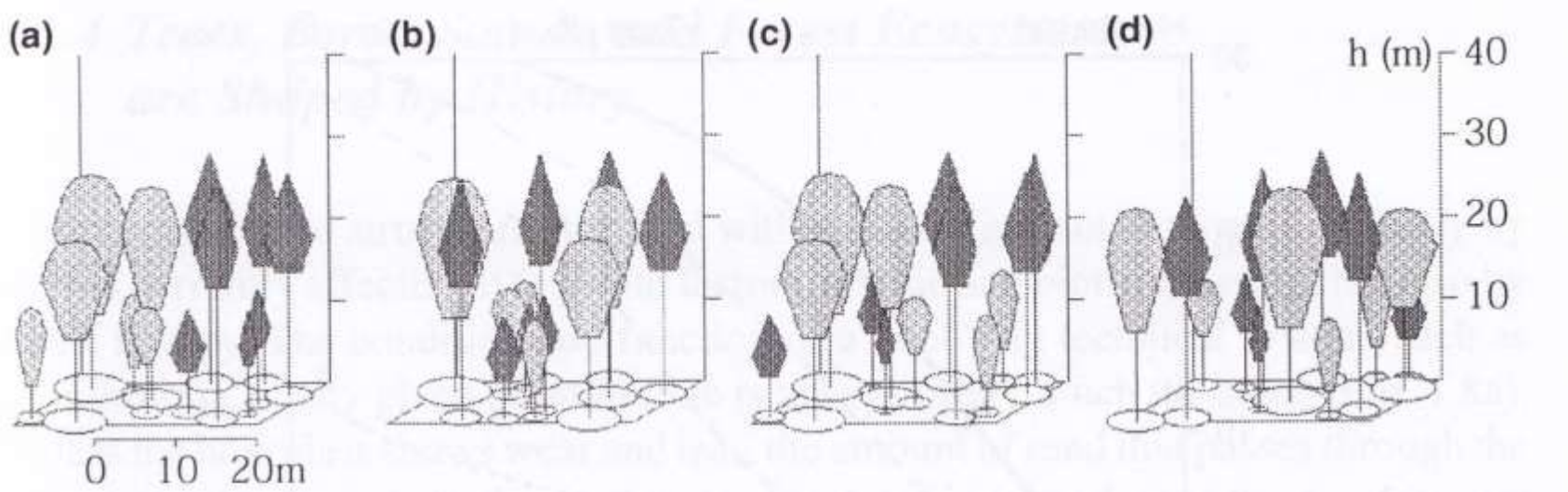


Fig. 1.5 The four Norway spruce–European beech mixed stands have equal mean and cumulative values, diameter, and height distributions but differ in structure: (**a**) group mixtures of Norway spruce and European beech, (**b**) groups of regeneration, two-layered stands with Norway spruce under European beech, (**c**) European beech under Norway spruce, and (**d**) Norway spruce and European beech in single tree mixtures. Their different spatial configuration reflects different pathways of development

Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

Characteristics of forest systems:
Forests are strongly structured systems

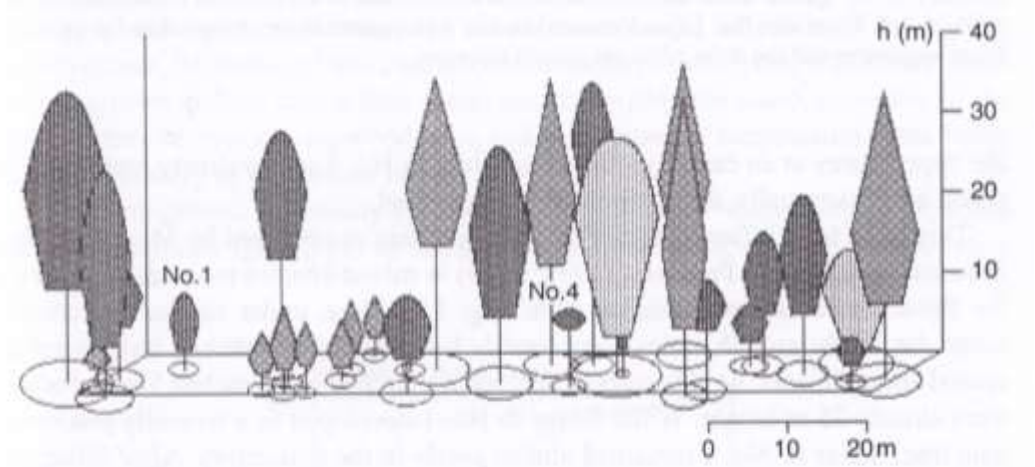


Fig. 1.6 Stand profile for a 5-m-wide strip through the Norway spruce–Silver fir–European beech selection forest experimental plot Freyung 129/2, in the survey year 1980. Norway spruce is *shaded grey*, Silver fir *dark grey*, and European beech *light grey*. Silver fir No. 1 suffers less from competition for light than No. 4 whose crown is already receding

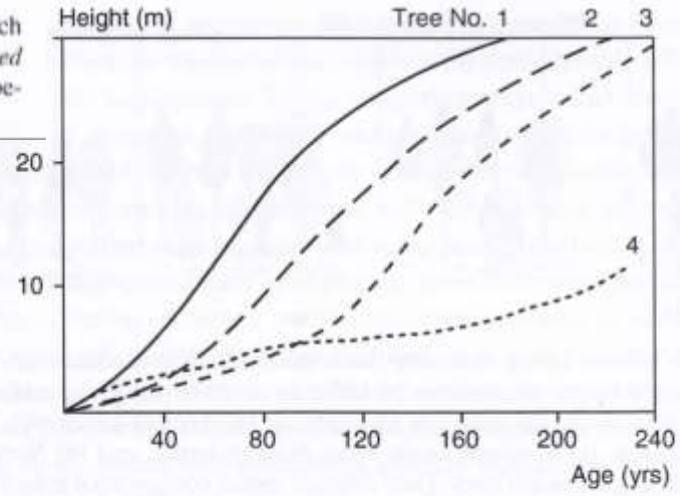


Fig. 1.7 Height development of Silver fir in relation to spatial growth constellation in a multi-layered Norway spruce–Silver fir–European beech mixed stand in the Bavarian Alps (after Magin 1959, p. 16). From tree No. 1 (predominant) to No. 4 (suppressed) the competition for growing space aggravates and the delay of height growth increases

Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

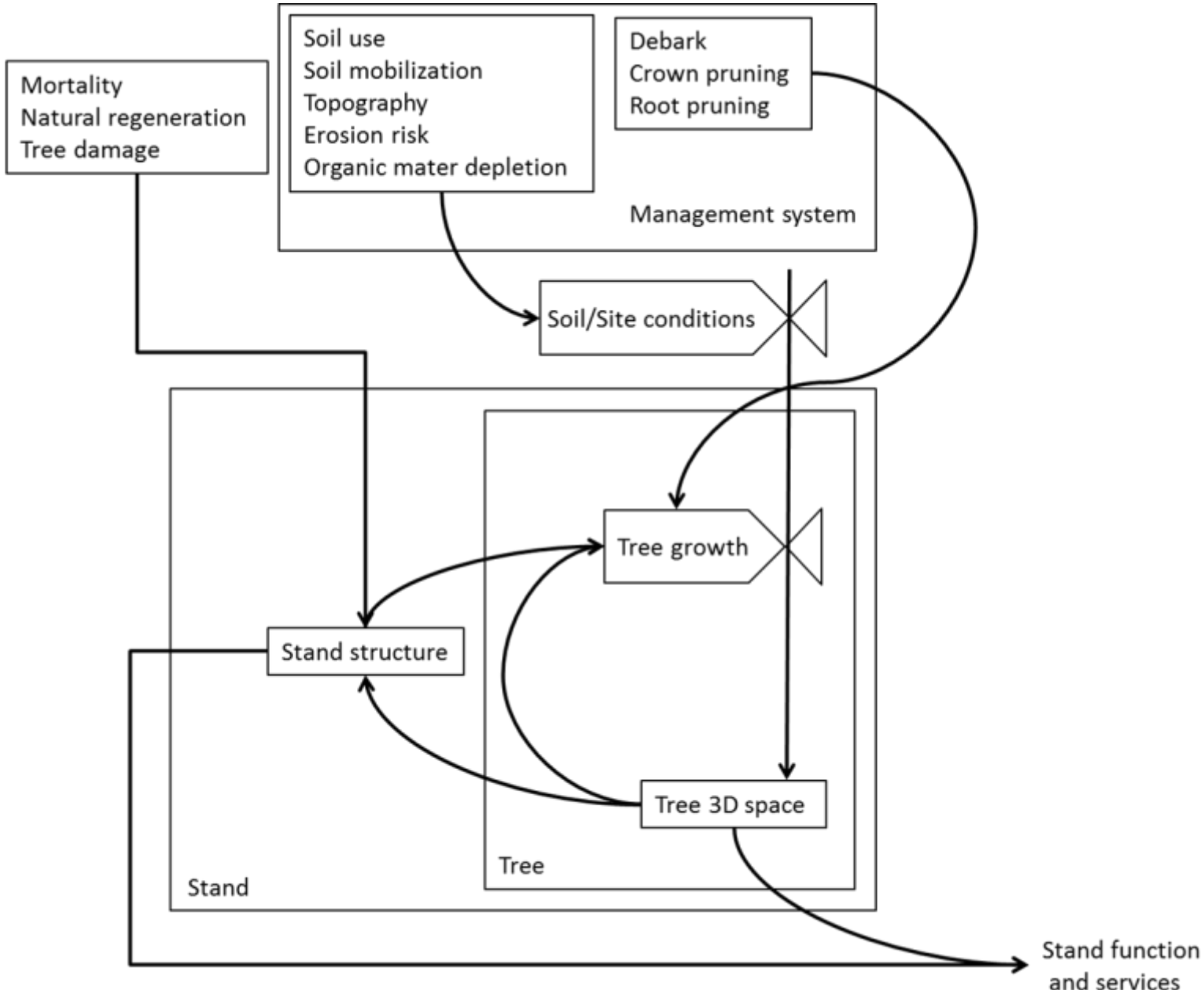
The complexity of integrating spatial and time processes multi-scale forestry models

	Process	Duration of process	Spatial compartment	Pattern and indicator
+4	Evolution	Millenniums	Continents	Species and genotypes
+3	Succession	Centuries	Landscapes	Plant-animal community
+2	System renewal	Decades-centuries	Ecosystems	Natural regeneration
+1	Stand development (changes of pools in biomass-humus)	Decades	Forest stands (ecosystem section)	Age class-matter budget of the soil
0	Element cycle	Year	Tree-tree groups	Matter budget of the ecosystem
–1	Development of plant organs (leafs, fine roots, fruits, wood)	Weeks-month	Tree+Forest floor vegetation	Tree foliation
–1	Decomposition	Weeks-month	Soil horizon	Humus form
–2	Assimilation-matter uptake	Hours-weeks	Leaf-root	Carbon and ion allocation
–2	Mineralisation	Hours-weeks	Soil aggregate	Soil solution chemistry
–3	Biochemical reaction	Minutes	Cell	Biochemical pattern
–3	Soilchemical reaction	Seconds	Mineral surface	

Fig. 1.11 Processes in forest ecosystems in relation to their temporal and spatial scales, and the patterns and structures they produce (from Ulrich 1993)

Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

Conceptual model for forest dynamics



Characteristics of forest systems:
Forest ecosystems are hierarchically organized

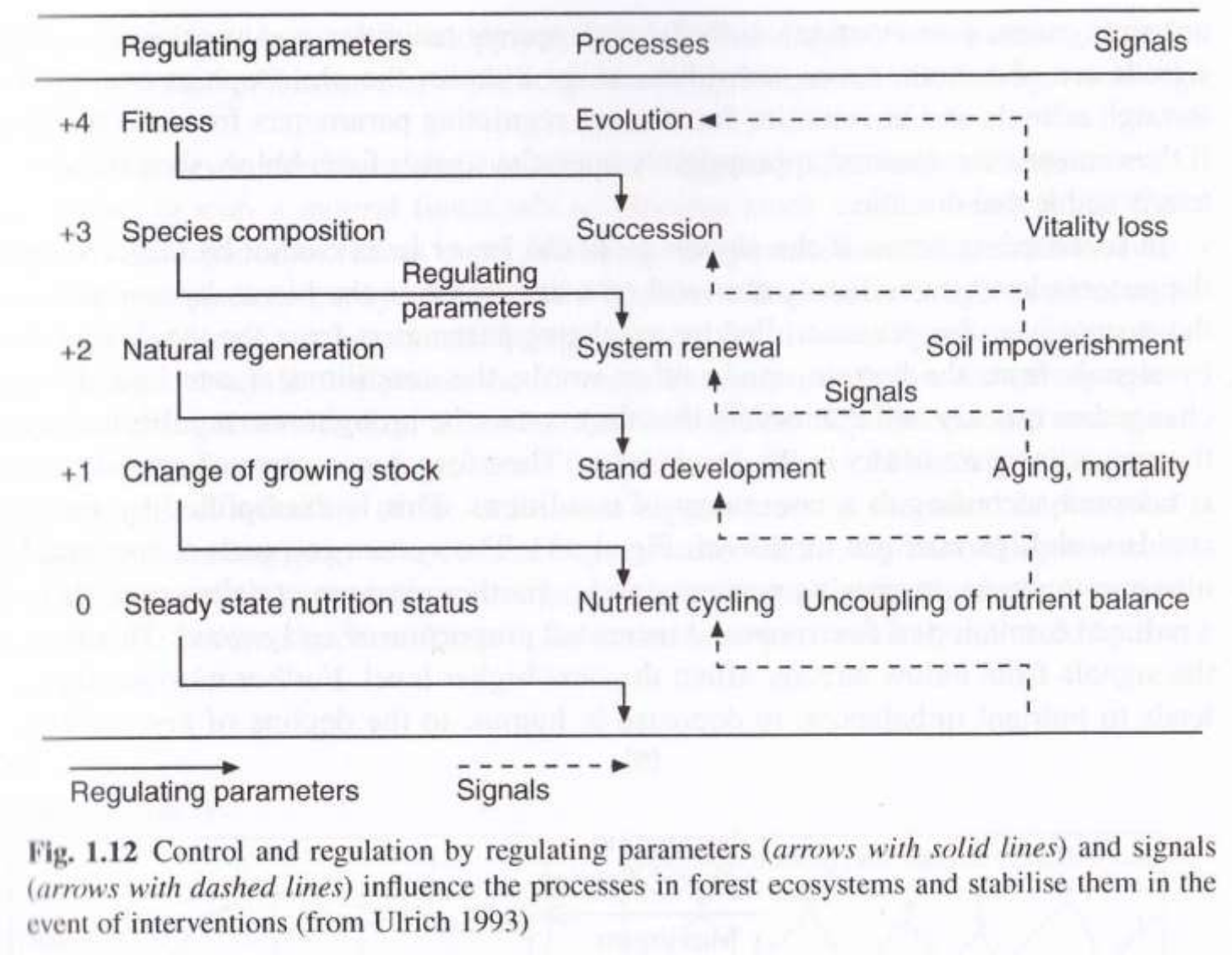


Fig. 1.12 Control and regulation by regulating parameters (*arrows with solid lines*) and signals (*arrows with dashed lines*) influence the processes in forest ecosystems and stabilise them in the event of interventions (from Ulrich 1993)

Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

Characteristics of forest systems:
Forest ecosystems are hierarchically organized

The stability of forest ecosystems depends on the characteristics:

Resilience: Ability of the system to stay in balance within a range of disruptions

Elasticity: Ability of the system to return to the equilibrium situation after a disturbance

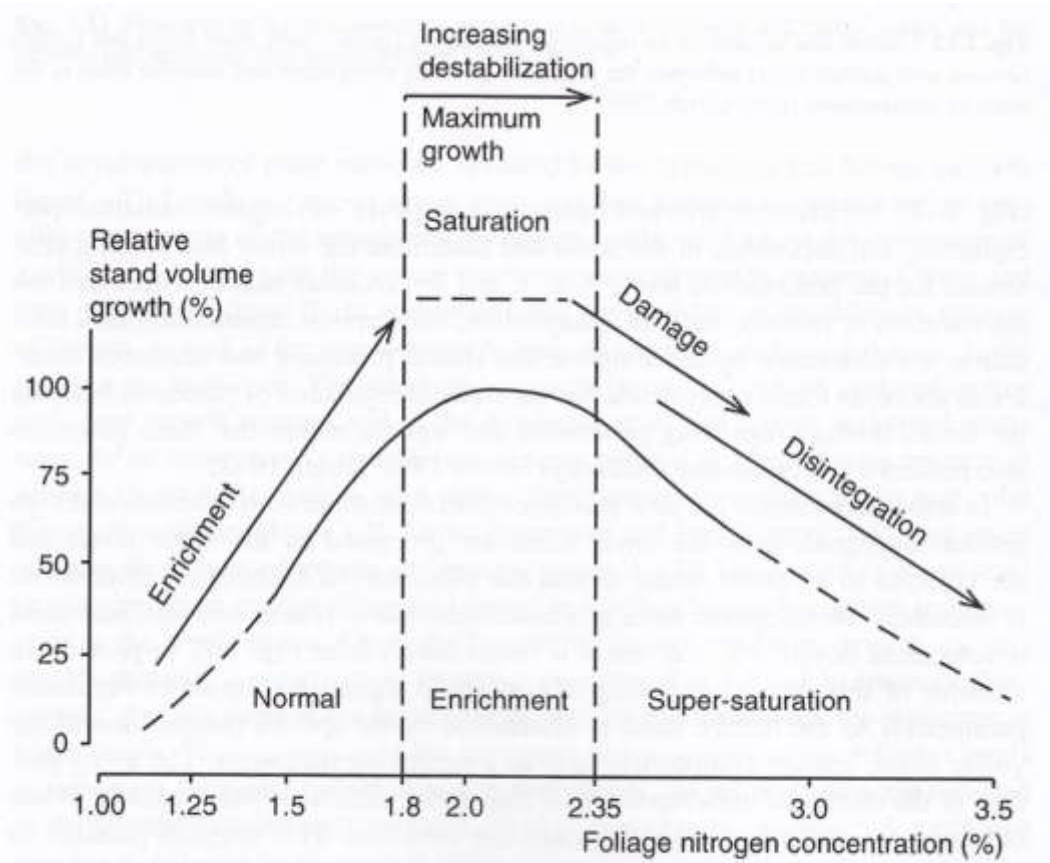


Fig. 1.13 Relationship between nitrogen availability (N concentration in needles) and stand volume increment (volume increment as a per cent of the maximum increment) for Scots pine stands in the East-German lowlands affected by atmospheric nitrogen import (from Hofmann et al. 1990,

Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

Characteristics of forest systems:
Forest ecosystems are hierarchically organized

Elasticidade:

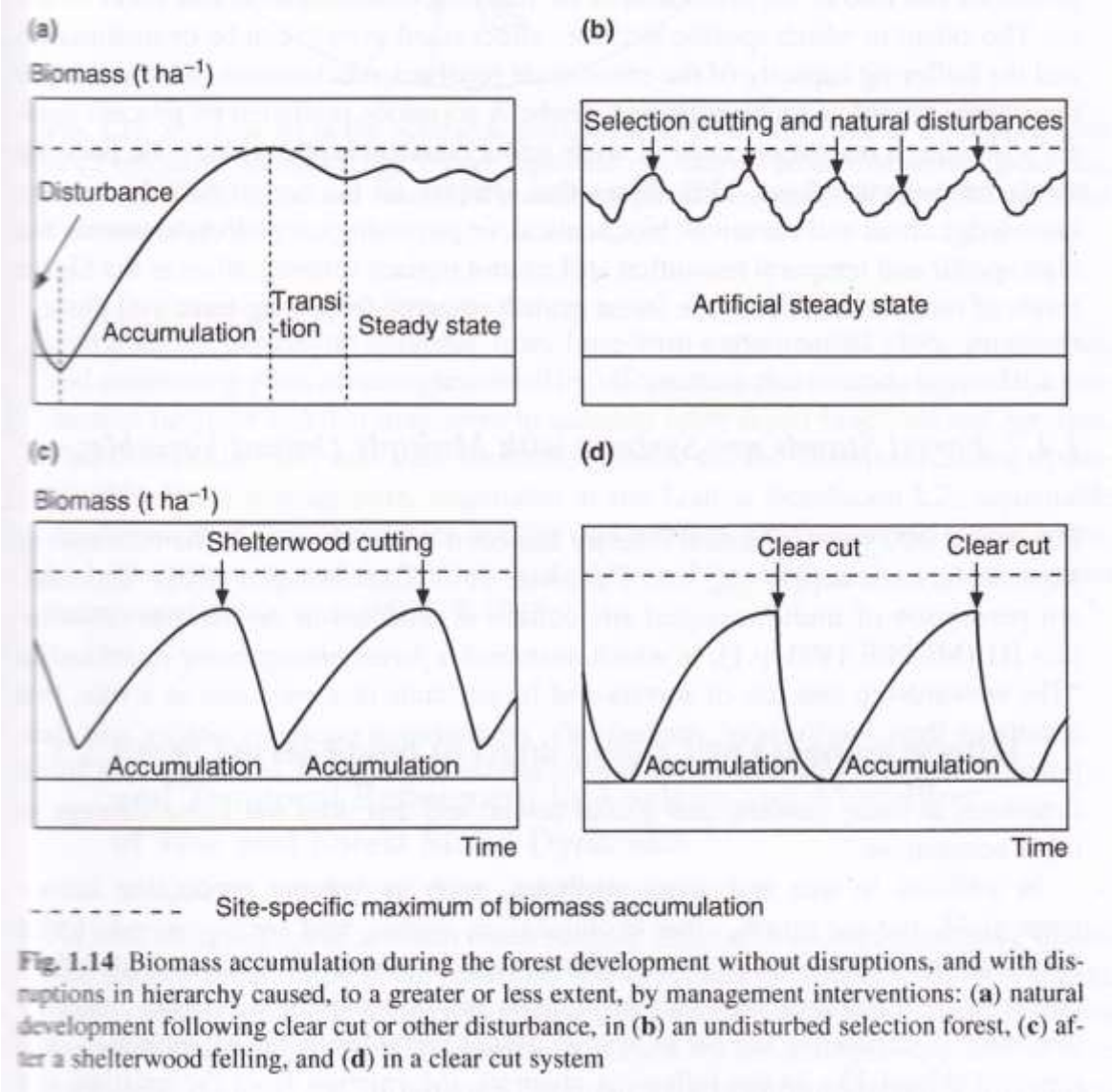


Fig. 1.14 Biomass accumulation during the forest development without disruptions, and with disruptions in hierarchy caused, to a greater or less extent, by management interventions: (**a**) natural development following clear cut or other disturbance, in (**b**) an undisturbed selection forest, (**c**) after a shelterwood felling, and (**d**) in a clear cut system

Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

Knowledge construction

Remeasuring a permanent sample plot in old-growth forest, Olympic National Park, Washington.

Instalação de dispositivos experimentais para monitorização da dinâmica dos ecossistemas florestais

Gaging station to monitor streamflow on a small watershed, H. J. Andrews Experimental Forest, Willamette National Forest, Oregon.

Navajo tribal representatives discussing forestry issues with a scientific team, Navajo Indian Reservation, Arizona.

Construction crane providing access to 5.6 acres of old-growth Douglas-fir–western hemlock forest at Wind River Canopy Crane Facility, Gifford Pinchot National Forest, Washington.

Construction of growth models: The models are hierarchically organized

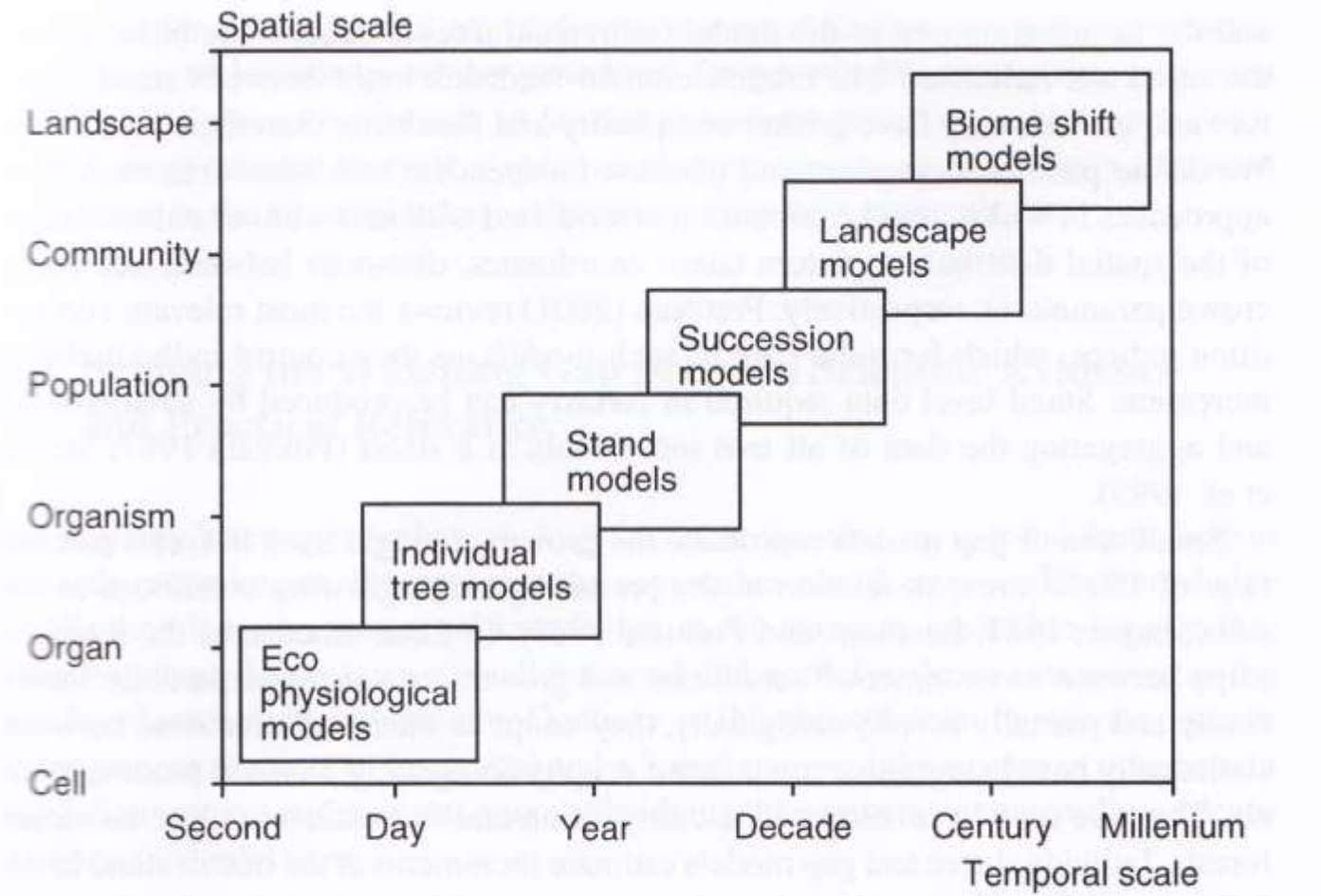


Fig. 1.17 The spatial and temporal aggregation of modelling processes and structures increases from ecophysiological process models to management models to succession, landscape, and biomes shift models

Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

Construction of growth models:
Co-instruction of experimental devices with scale overlays

- Experimental devices overlapped as an answer to the questions:
- Multiple miscellaneous:
  - Transcriptomic studies do not respond to hypotheses at higher levels
- Lower-level results when in overlapping experiments can be used for estimates at higher levels

	H_I	H_{II}	H_{III} ···	H_{XIII}
Stand-population	–	–	**	***
Individual plant	–	*	*	**
Organ	–	*	–	–
Cell	**	**	–	–
Gene-transcript	***	***	–	–

Fig. 1.18 Multiscale falsification of hypotheses H_I to H_{XIII} schematically. Results are traced from gene or transcript level upward to organ, individual plant, stand, and population level. Evidence at lower levels does not necessarily mean relevance at the plant or stand level

Scales	Observed vs. predicted	
Landscape	L_{obs}	L_{pred}
Stand	S_{obs}	S_{pred}
Plant	P_{obs}	P_{pred}
Organ	O_{obs}	O_{pred}
Cell	C_{obs}	

Fig. 1.19 Knowledge gain through scale-overlapping analysis, here from cell to organ, plant, stand, and landscape level (denoted C, O, P, S, and L). The observed system variables at a certain level (C_{obs}, O_{obs}, P_{obs}, S_{obs}, and L_{obs}) can be used to predict the expected behaviour for the next-higher level (O_{pred}, P_{pred}, S_{pred}, and L_{pred}) through linear temporal or spatial upscaling (symbolised by the ladders). Deviations between the observed and predicted values at the next higher level indicate knowledge gaps and the limited relevance of partial processes for the whole. Further explanation is given in the text

Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

Construction of growth models: Interdisciplinary links between indicator variables

Scales	Structural indicator		System attribute
Landscape	Fragmentation	~	Recreation value
Stand	Vertical structure	~	Habitat
Plant	h/d-quotient	~	Stability
Organ	Defoliation	~	Vitality

Fig. 1.20 Structural system attributes at the organ, plant, stand, and landscape level play an important role for horizontal knowledge integration. They are relatively easy to estimate or measure and facilitate a link (symbolised by wavy lines) to other relevant system attributes like vitality, stability, habitat and species diversity, or protection and recreation value of a forest

Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

Construction of growth models:
Links between growth models and forest inventories

- More complex experimental devices with spatial dendrometric data collection combined with station data (soil, topography, biodiversity, etc.) allow you to adjust/calibrate models for ecosystems.
- These models allow generating startup data for hybrid models that allow simulation taking into account climate change scenarios and thus generate solutions in simulation studies for all possible scenarios
- Thus, in this context, simulation studies are induced by inventory data, while in previous solutions growth was deduced from models based on less representative data.

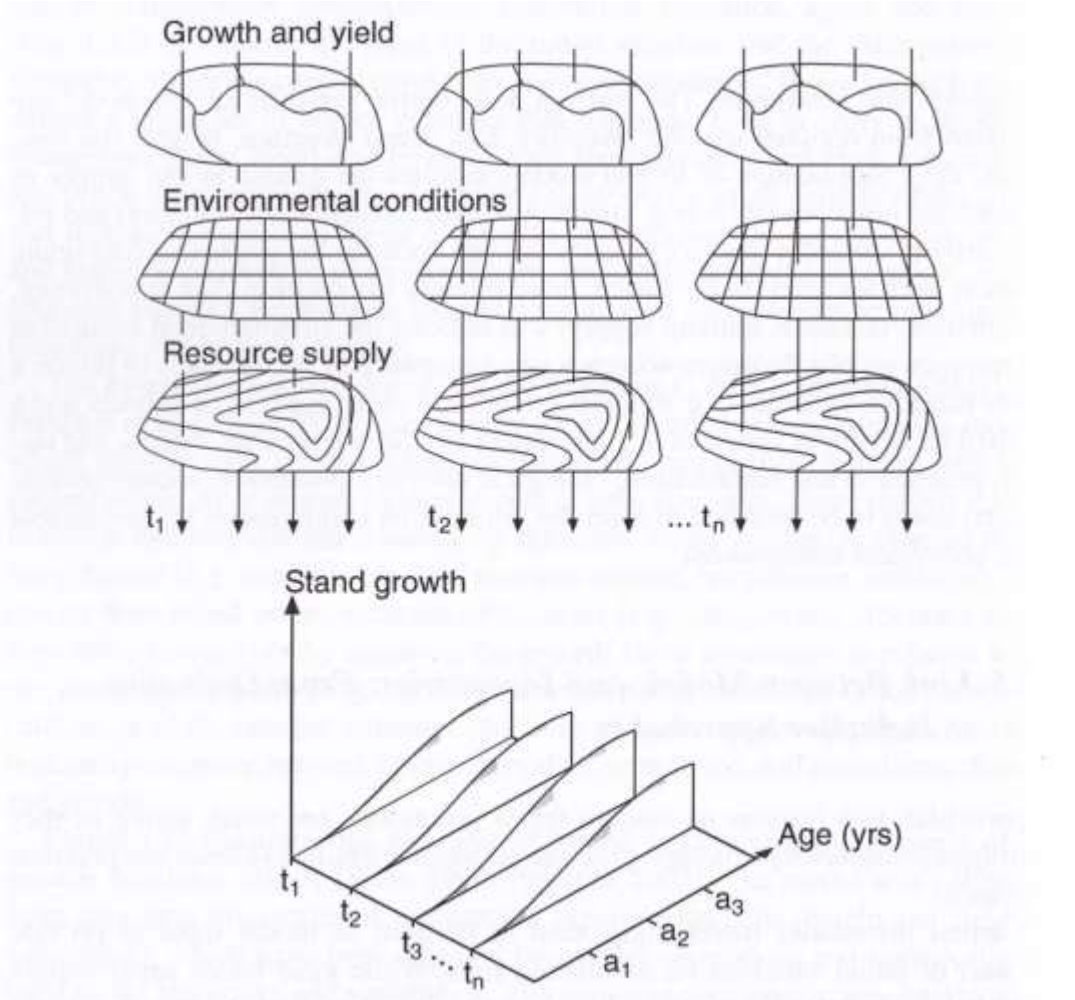


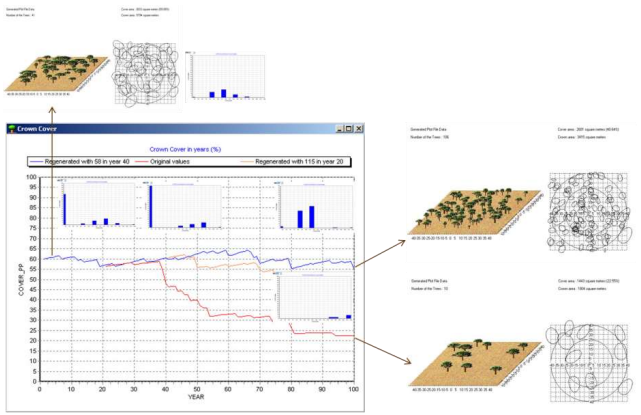
Fig. 1.24 Transition from deductive to inductive model approaches in schematic representation. See explanation in the text

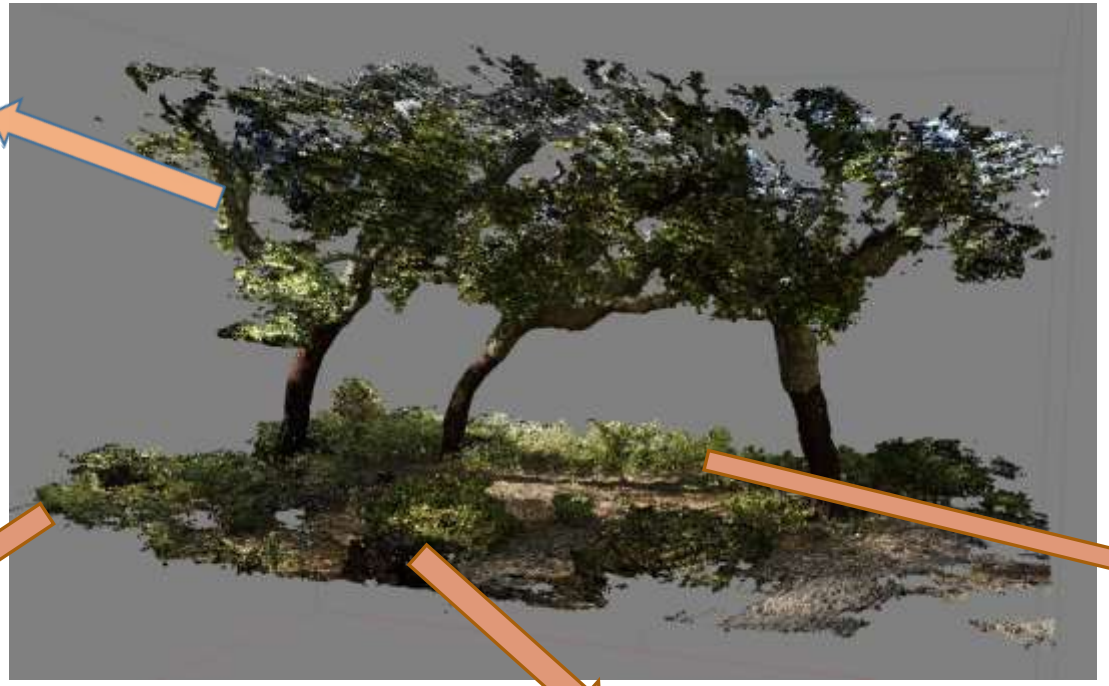
Adaptado de Pretzsch, H. (2009). Forest dynamics, growth and yield. Springer. 664 pp.

Definitions

The cork oak woodland:
A complex forest system

Structure and function





Management options

Management options:

- Natural and artificial regeneration
- Stem formation pruning (young stages)
- Thinning
- Sanitary thinning-mortality
- Crown pruning
- Debark-cork (minimum 9 year period)
- Shrub control:
    - Grazing
    - Disking
    - Shrub cutter
    - Permanent or temporary pasture crops

Site quality: soil and root distribution

Soil type, mineral and organic matter components are the drivers to:

- Fertility
- Water storage capacity
- Biological porosity and microbiome
- Tree/shrub root system distribution
- Herbaceous vegetation root system distribution
- Soil cohesion and resilience
- Site quality
    - Stand structure and density in time
    - Regeneration intensity and survival
    - Tree productivity and survival

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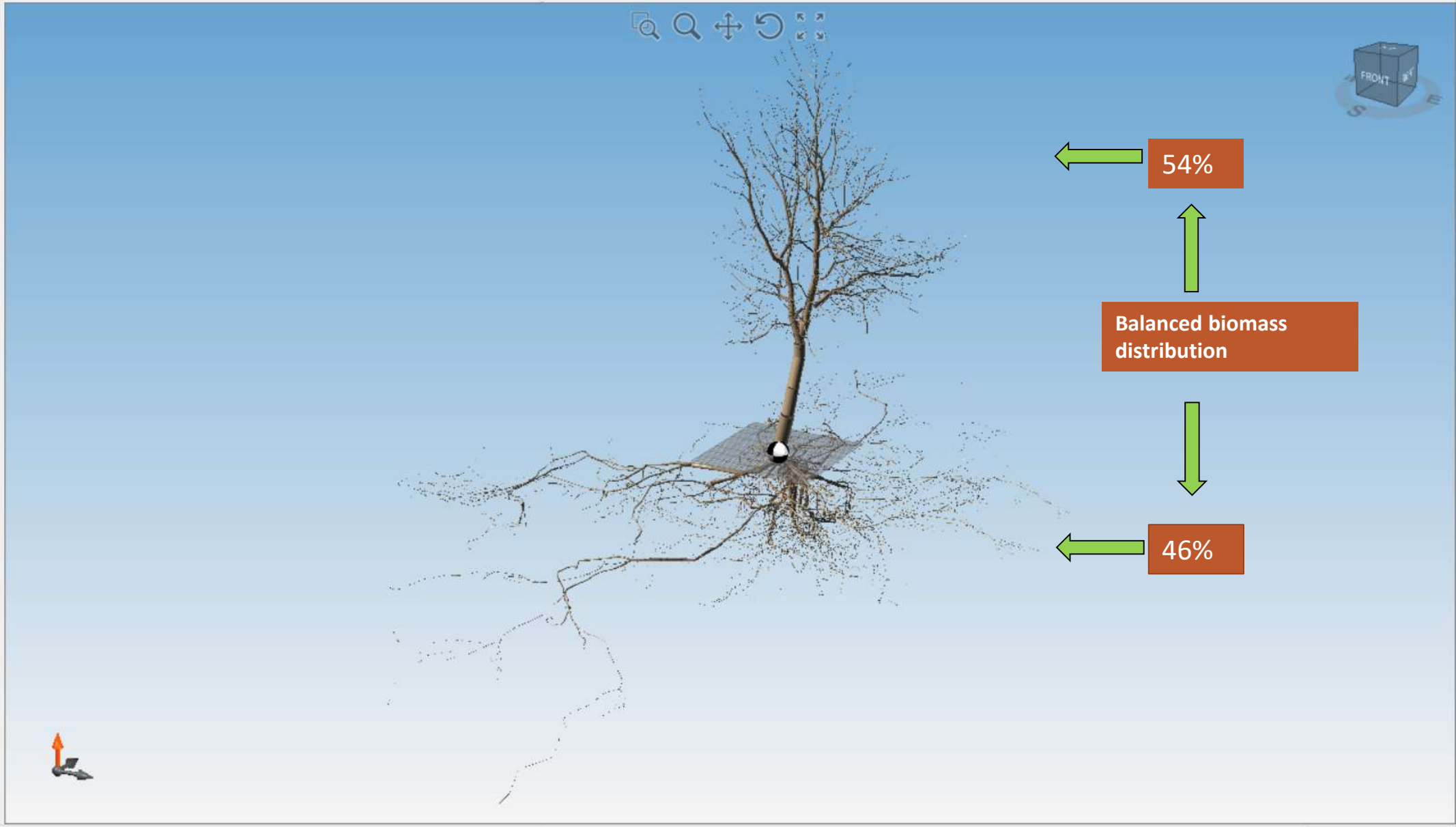

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	29	*<S4
	30	*<S5
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	91	*/A1/S1
	95	*/A1/S1
	96	*/A1/S1
	97	*/A1/S1
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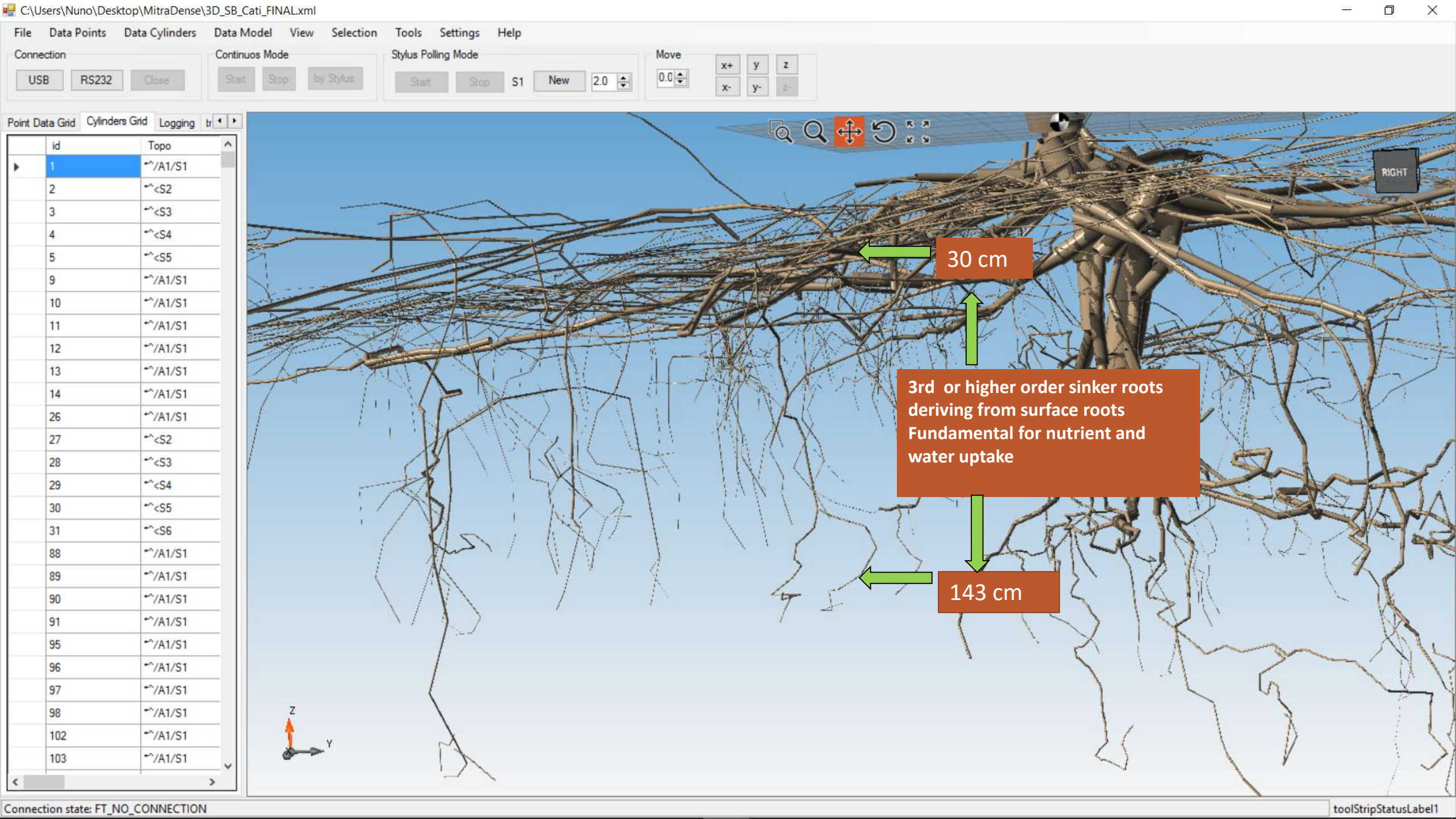
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97 */A1/S1
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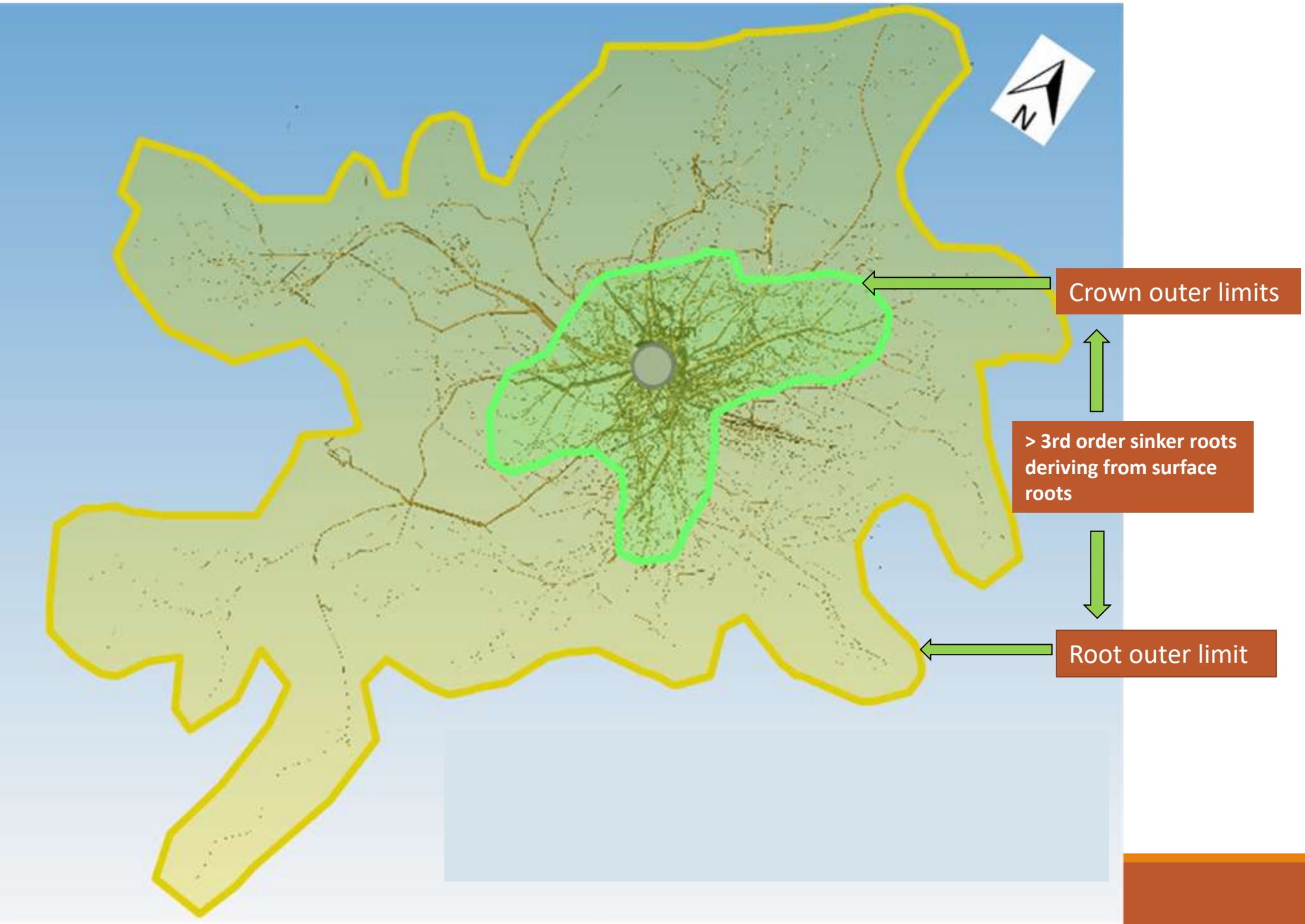
102 */A1/S1
103 */A1/S1
RIGHT
30 cm
3rd or higher order sinker roots deriving from surface roots Fundamental for nutrient and water uptake
143 cm
Z
Y
Connection state: FT_NO_CONNECTION
toolStripStatusLabel1


N
Crown outer limits
> 3rd order sinker roots deriving from surface roots
Root outer limit

Phases and silvicultural models

Initiation

Juvenile

Maturity
Regeneration

Old growth
Regeneration

As variantes de gestão

As variantes de gestão destes sistemas são distintas e têm abordagens técnicas, económicas financeiras diversas:

Florestais

Sobreiral / Azinhal: Centrado na maximização dos produtos lenhosos e não lenhosos arbóreos (cortiça, madeira, frutos, biomassa para energia), regulação do crescimento do estrato arbustivo e herbáceo com redução de radiação direta e competição radicular para reduzir a periodicidade das limpezas de matos (sem mobilização do solo). Atividades de uso múltiplo complementares (fruto, apicultura, cinegética, cogumelos, turismo) e, em momentos de baixo risco para a regeneração, e de acordo com a oferta alimentar, pastorícia, para fruto ou para vegetação herbácea e arbustiva após passagem do corta-matos.

Montado na vertente silvopastoril: o foco de gestão são os produtos lenhosos e não lenhosos das árvores (cortiça, madeira, frutos, biomassa para energia), sendo que as atividades pastoris e de uso múltiplo, complementares, visam em geral a minimização do impacto económico da regulação do risco de incêndio por controlo da vegetação arbustiva e são ajustadas (tipo de gado e encabeçamento) à oferta alimentar (peritada anualmente).

As variantes de gestão

As variantes de gestão destes sistemas são distintas e têm abordagens técnicas, económicas financeiras diversas:

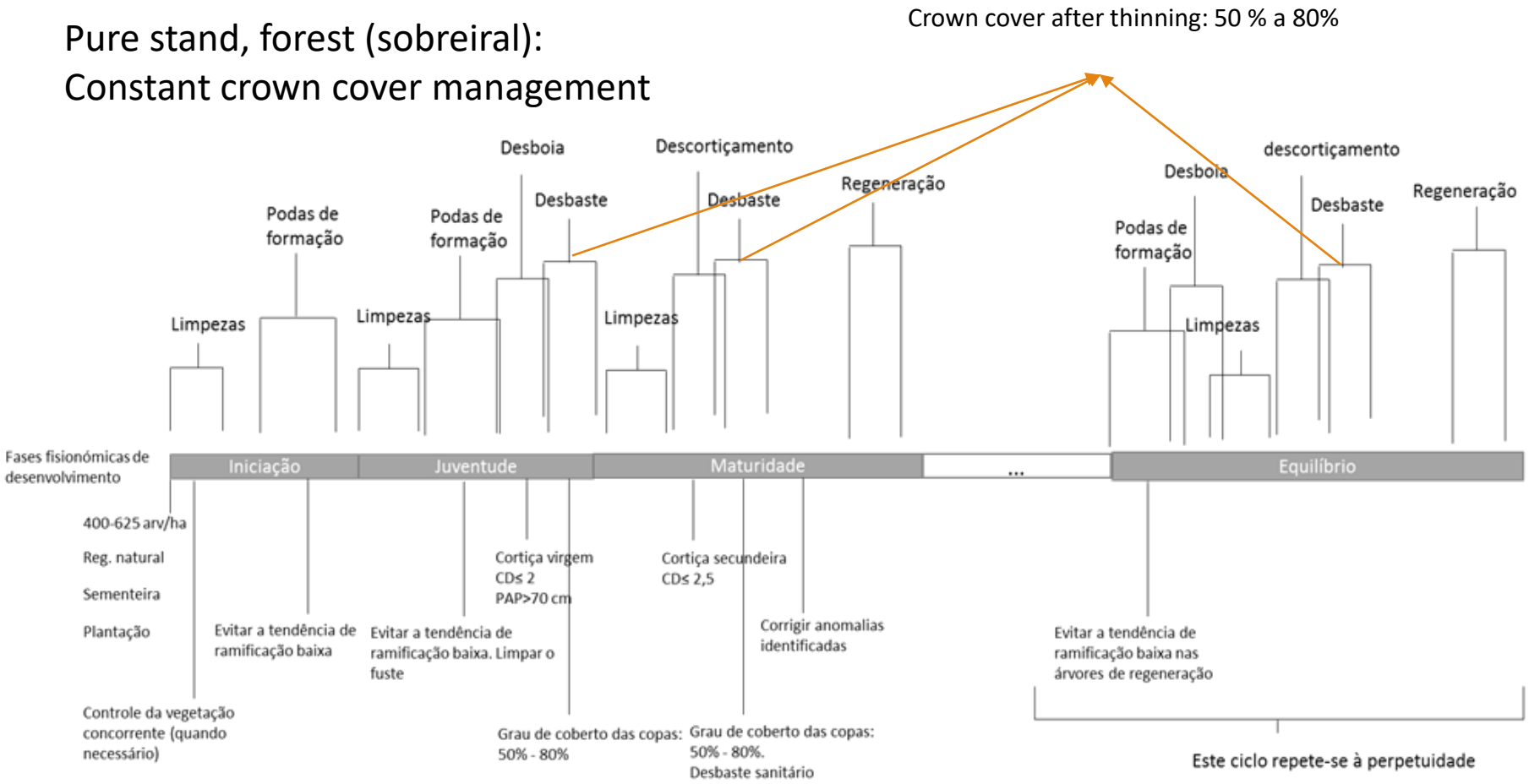
Agronómicas e pecuárias

Montado na vertente agrossilvopastoril e agropecuário com árvores dispersas: o foco de gestão são a componente pecuária e a pastagem associadas, sendo a produção lenhosa e não lenhosa das árvores e de uso múltiplo, complementares. Os itinerários agronómicos e pecuários são ajustados de forma a manter um efetivo pecuário permanente e os ajustamentos necessários para a componente florestal são definidos de acordo com a fase fisionómica das árvores.

Montado na vertente agroflorestal: Sistema de produção agrícola na entrelinha ou nos espaços de árvores plantadas ou regeneradas naturalmente , sendo a produção lenhosa e não lenhosa das árvores e de uso múltiplo, complementares. Os itinerários agronómicos são ajustados às culturas e os ajustamentos necessários para a componente florestal são definidos de acordo com a fase fisionómica das árvores.

Phases and silvicultural models

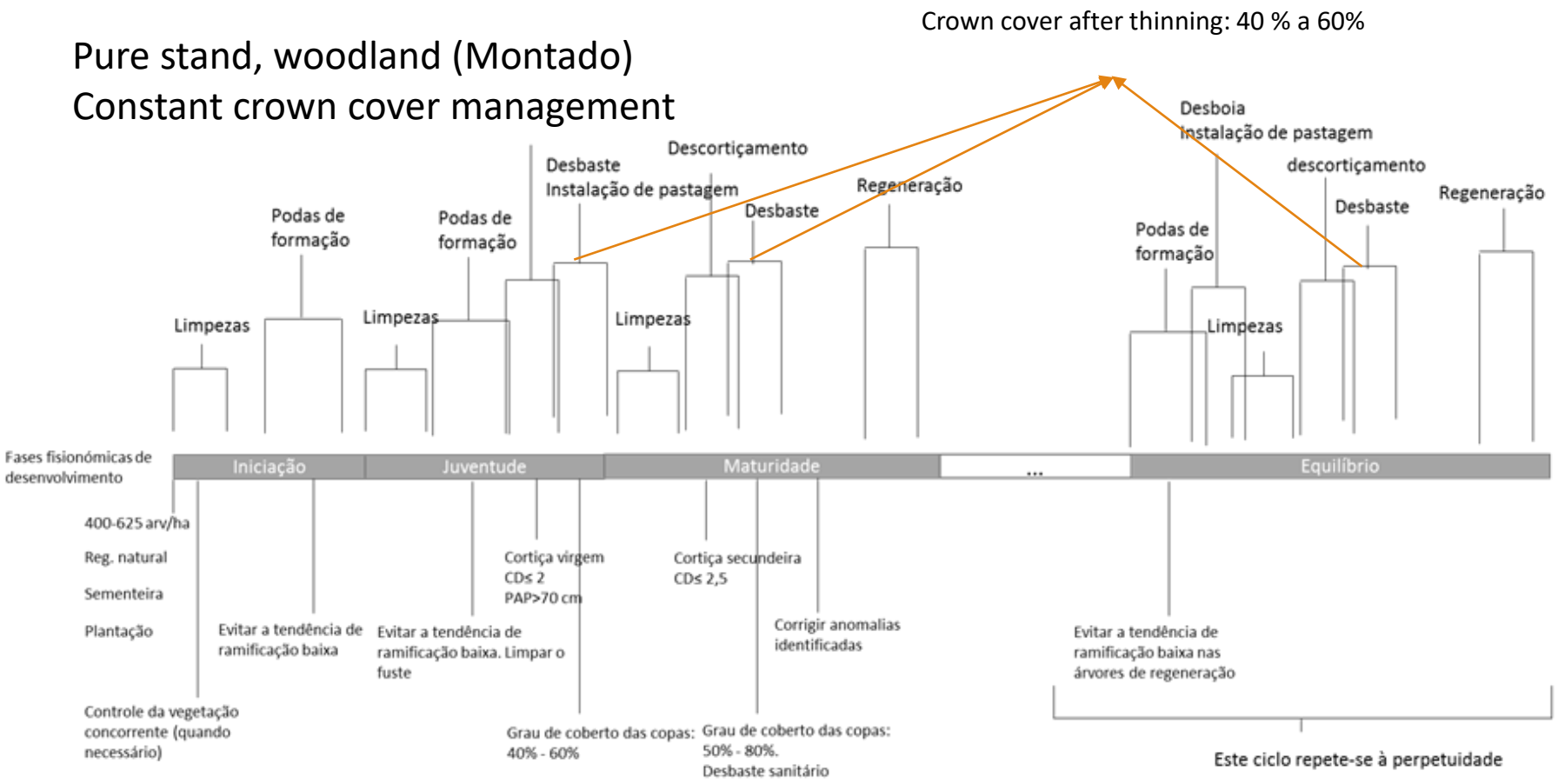
Pure stand, forest (sobreiral):
Constant crown cover management



Adaptado de Ribeiro & Dias (2017)

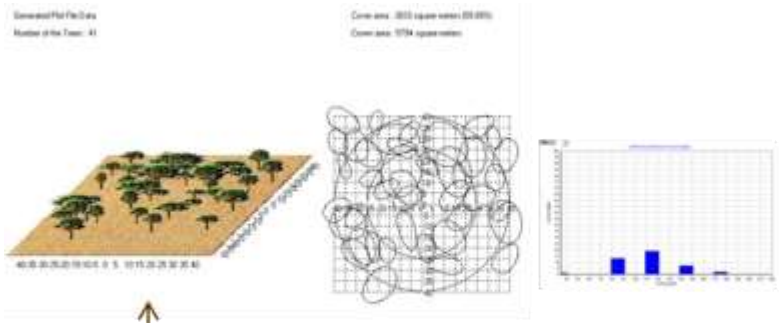
Phases and silvicultural models

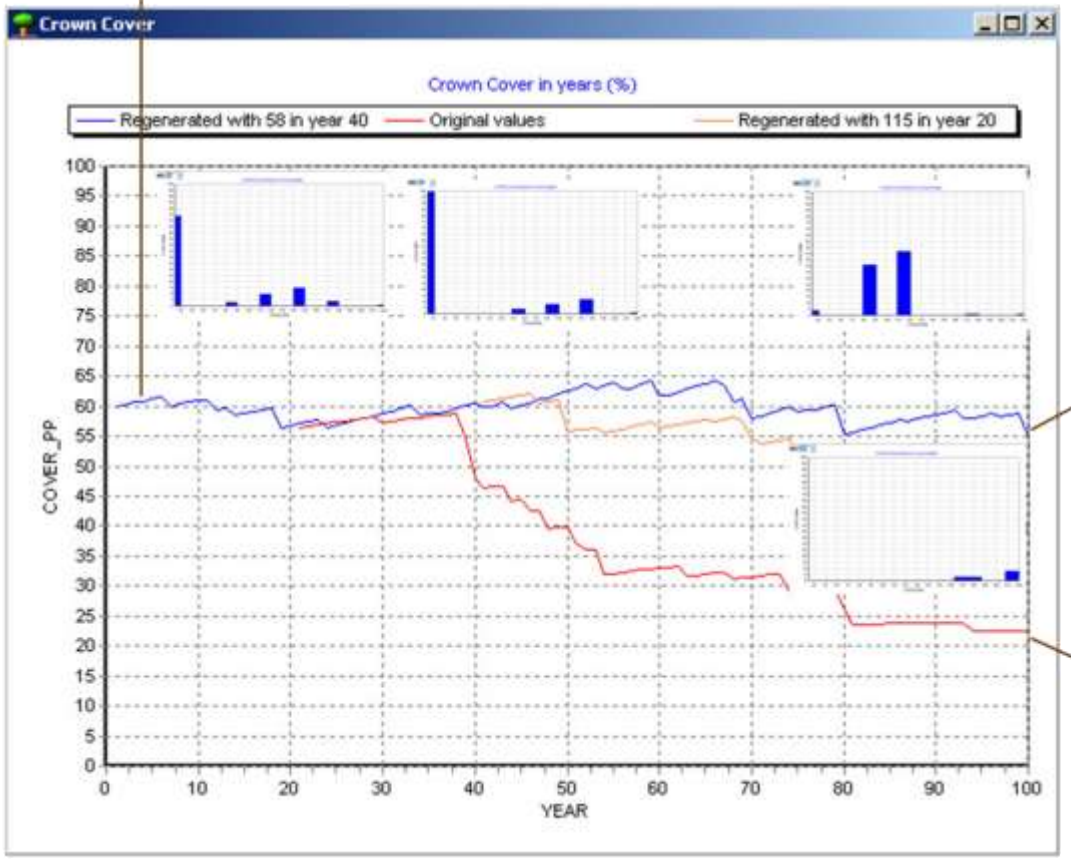
Pure stand, woodland (Montado)
Constant crown cover management

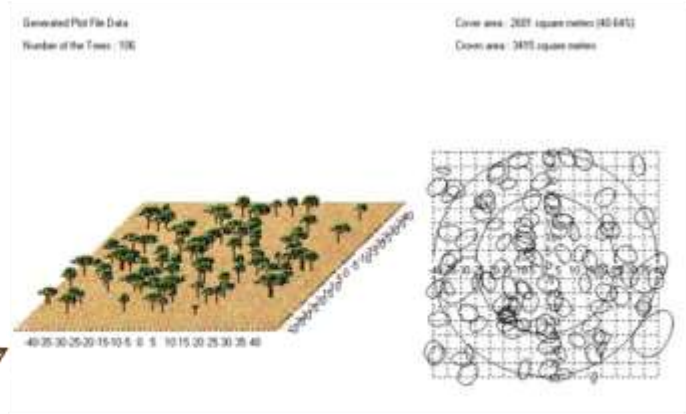


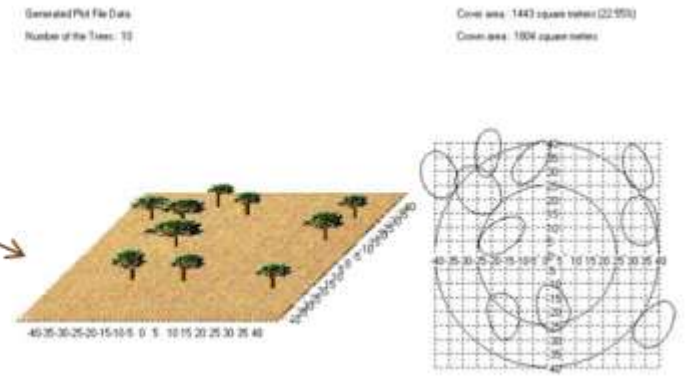
Adaptado de Ribeiro & Dias (2017)

Constant crown cover management



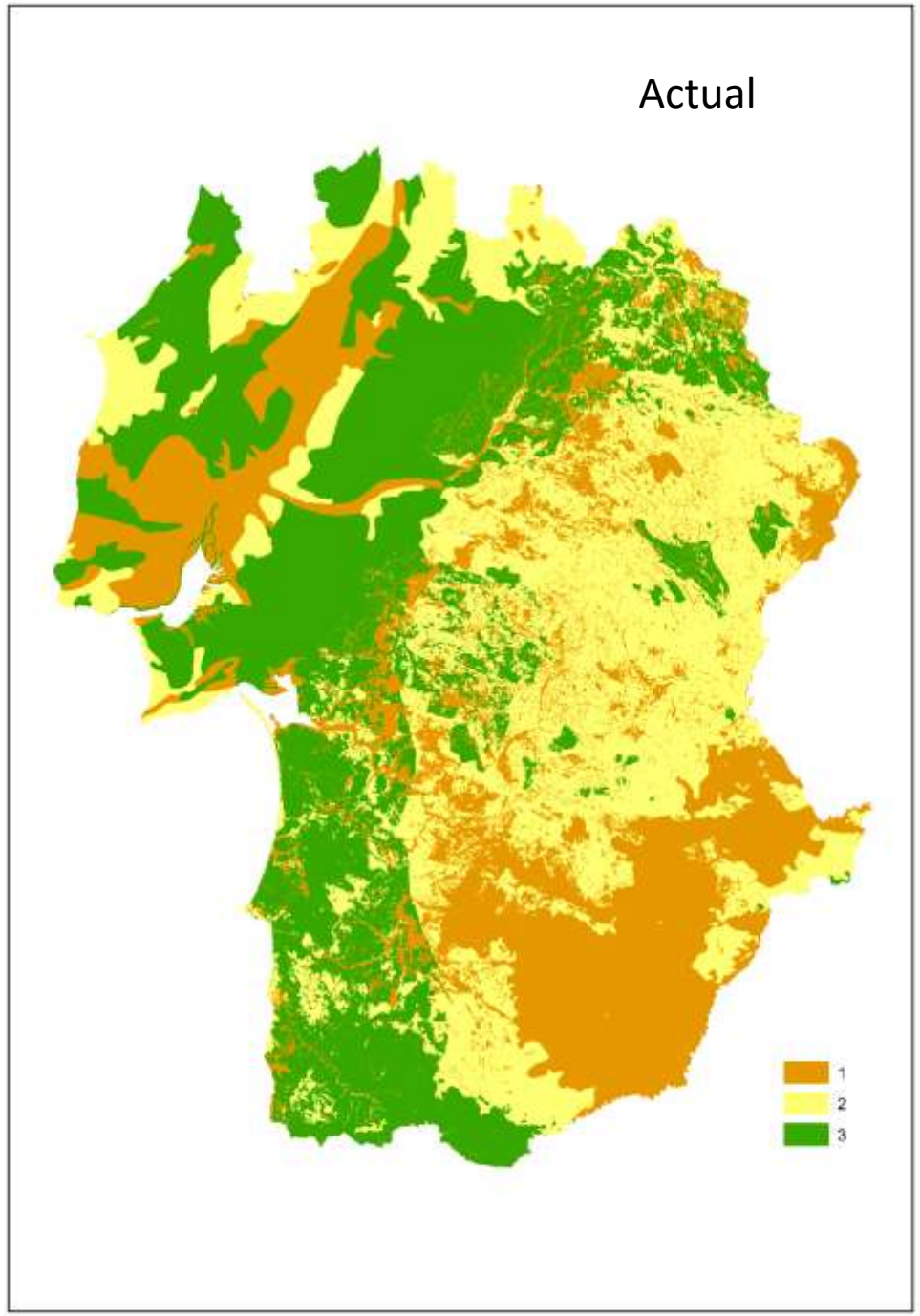






Scenario 45

Actual



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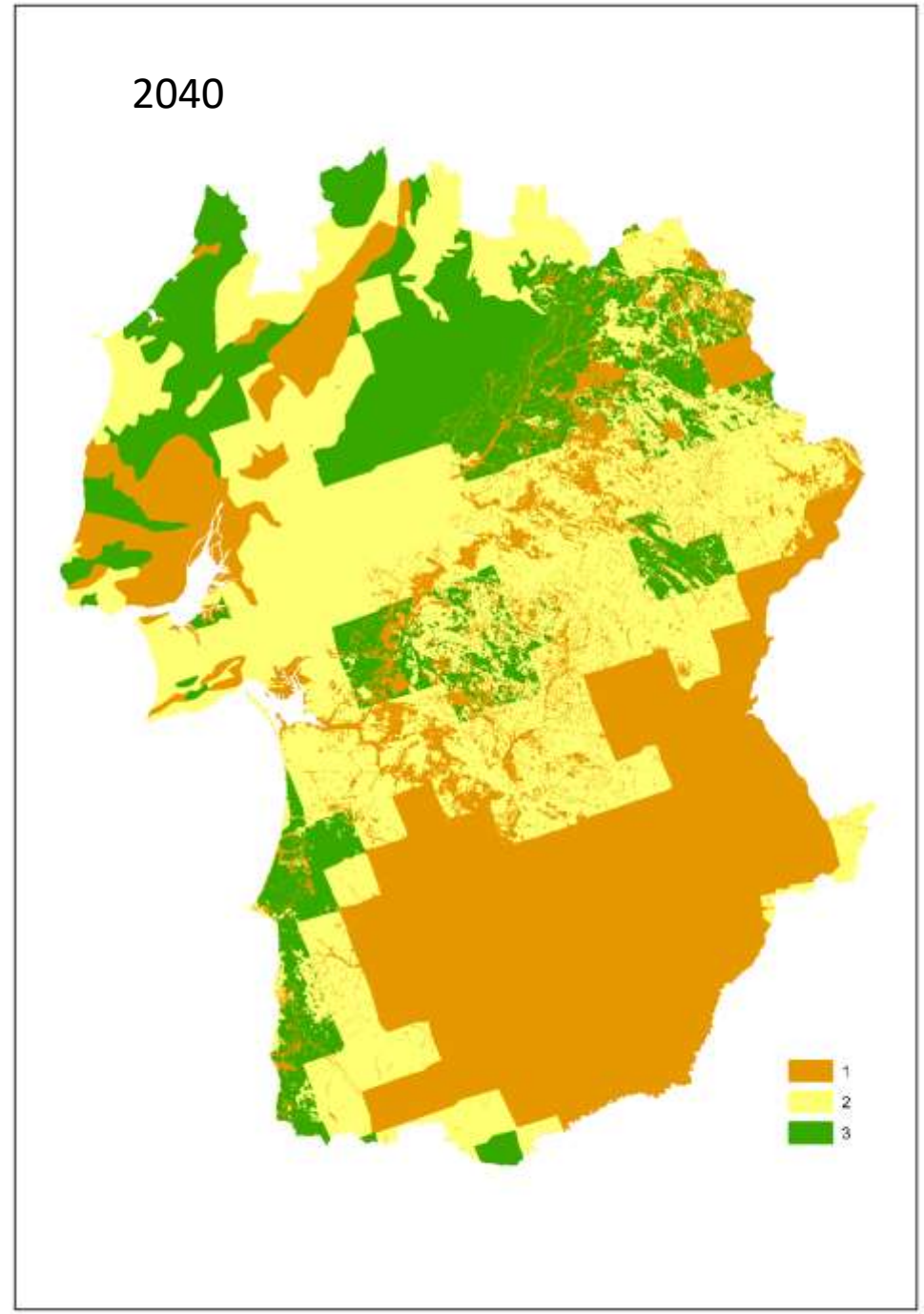
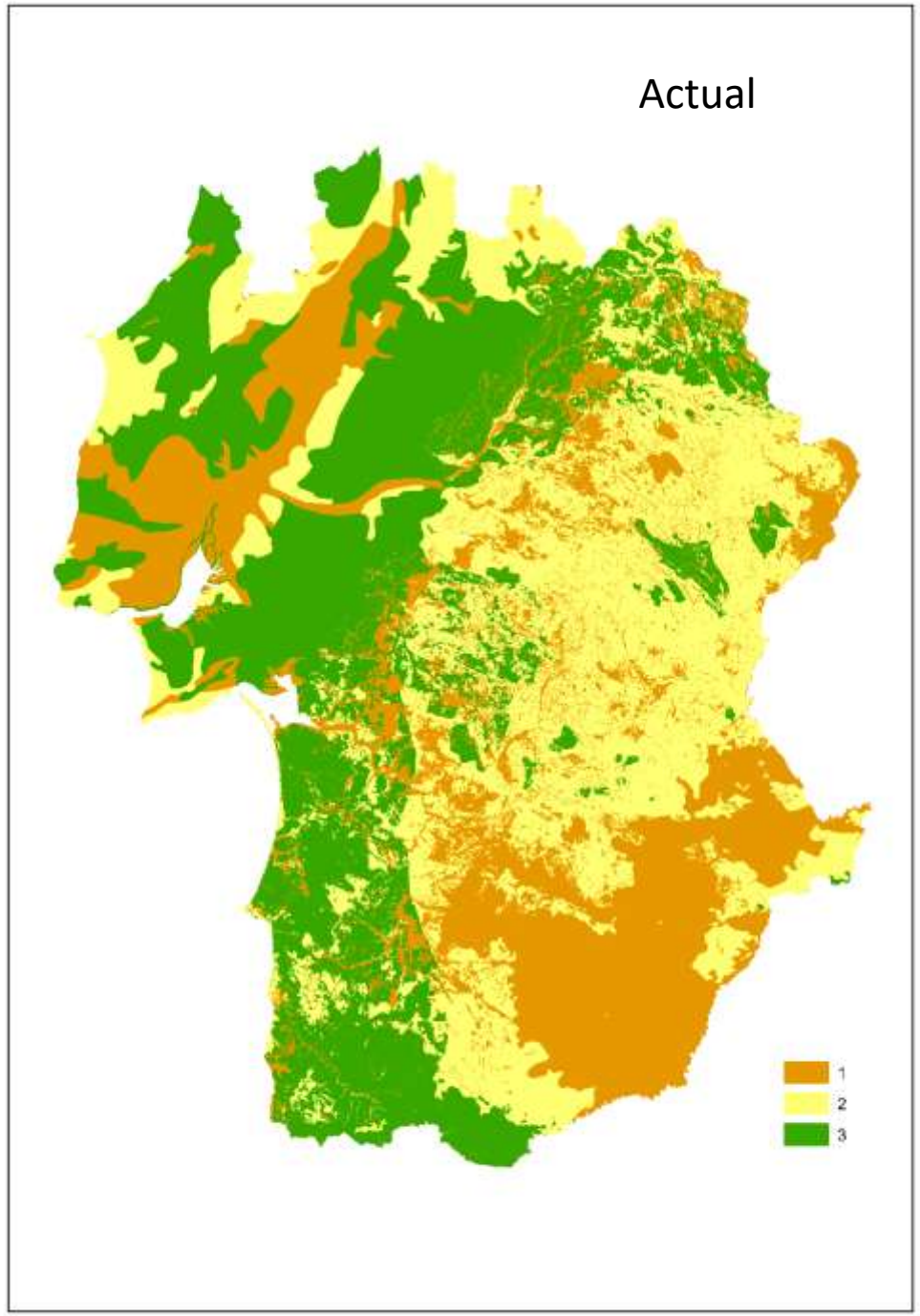


Scenario 45

Actual



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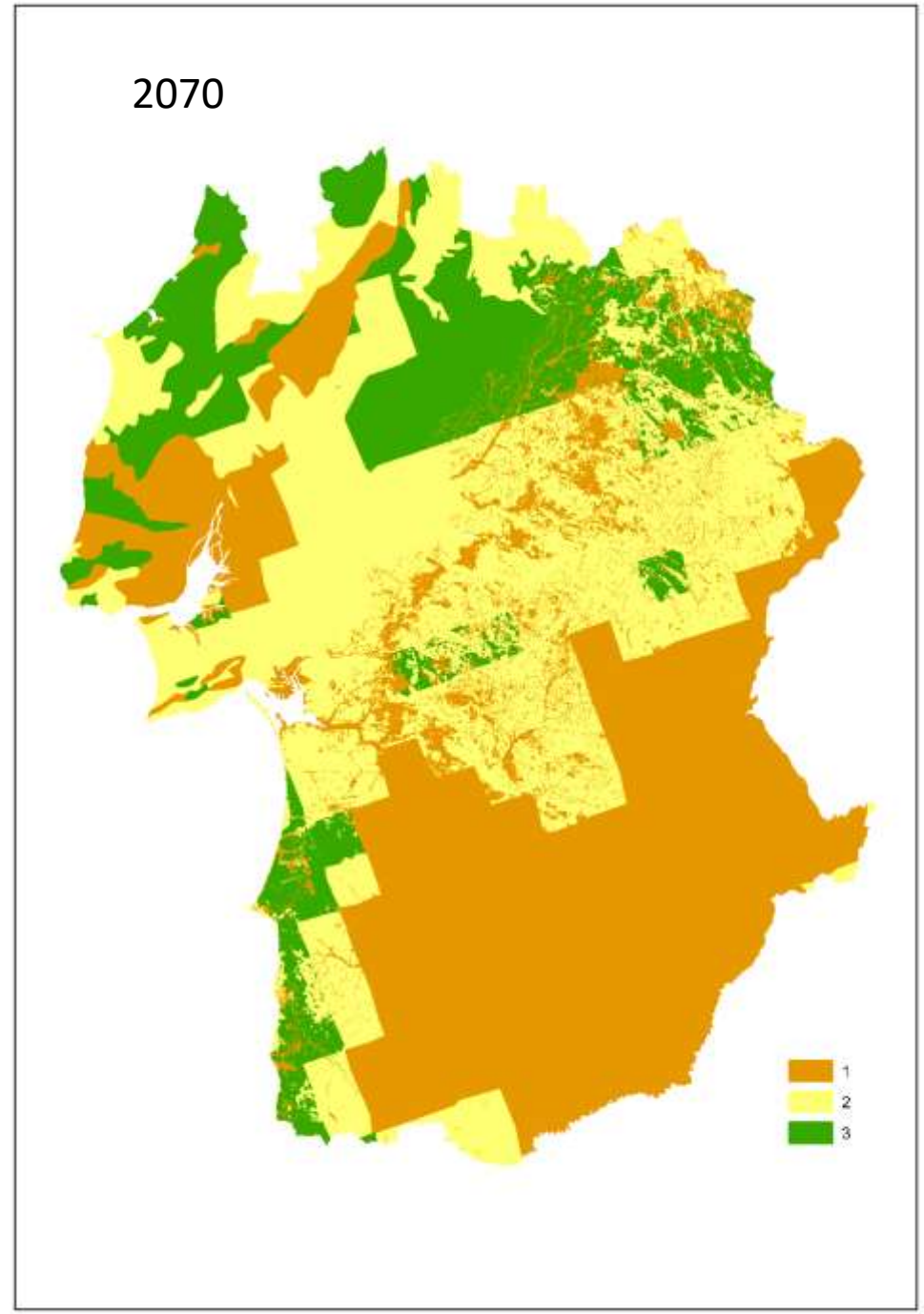
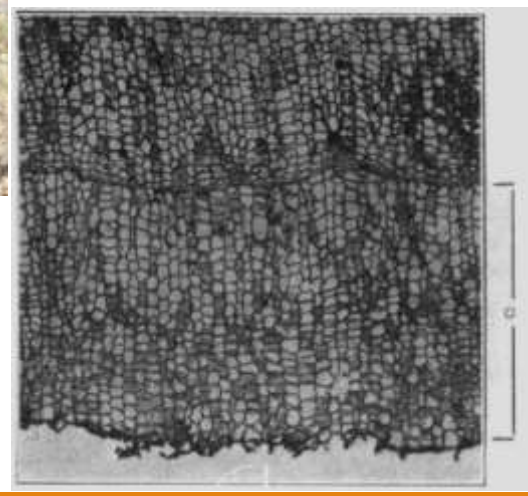
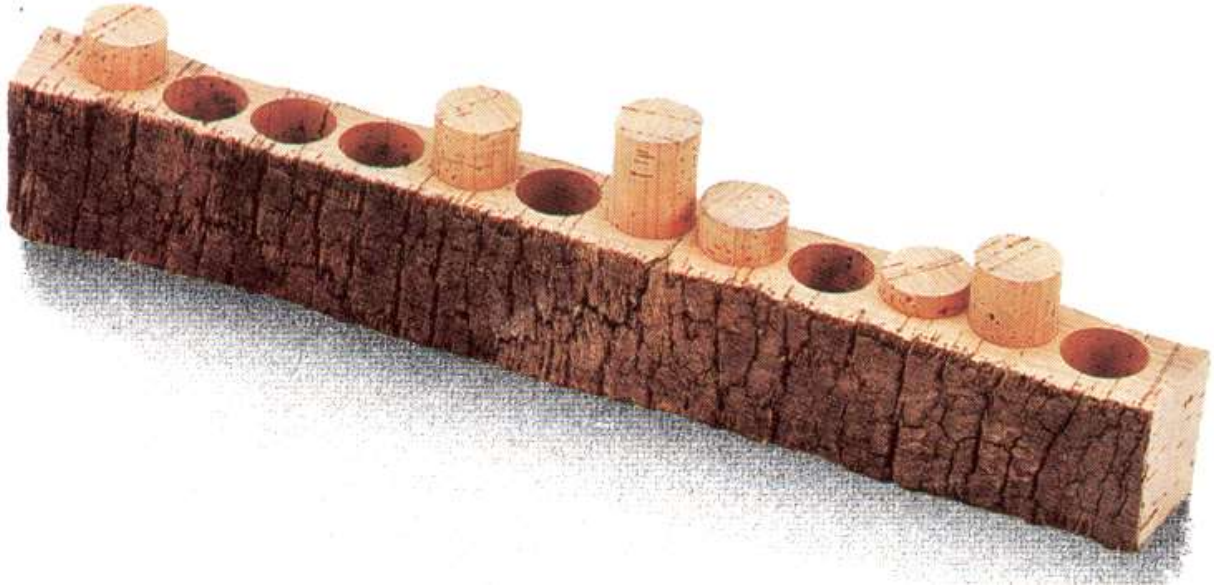


Cork: Debark and products

Debark possible due to not fully differentiated cells with weak cell walls



Cork: Debark and products



Natural stopper | Champagne | Technical:1+1 | Microgranulate | Capsulated | Hélix

Cork: Debark and products





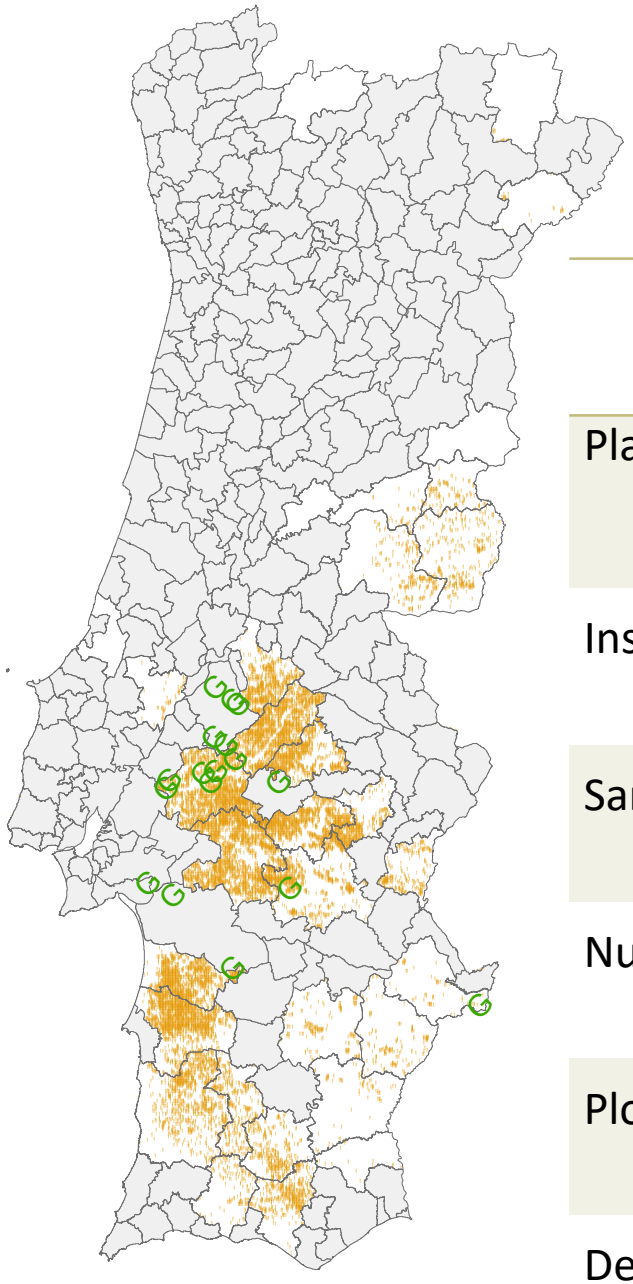







Monitoring system

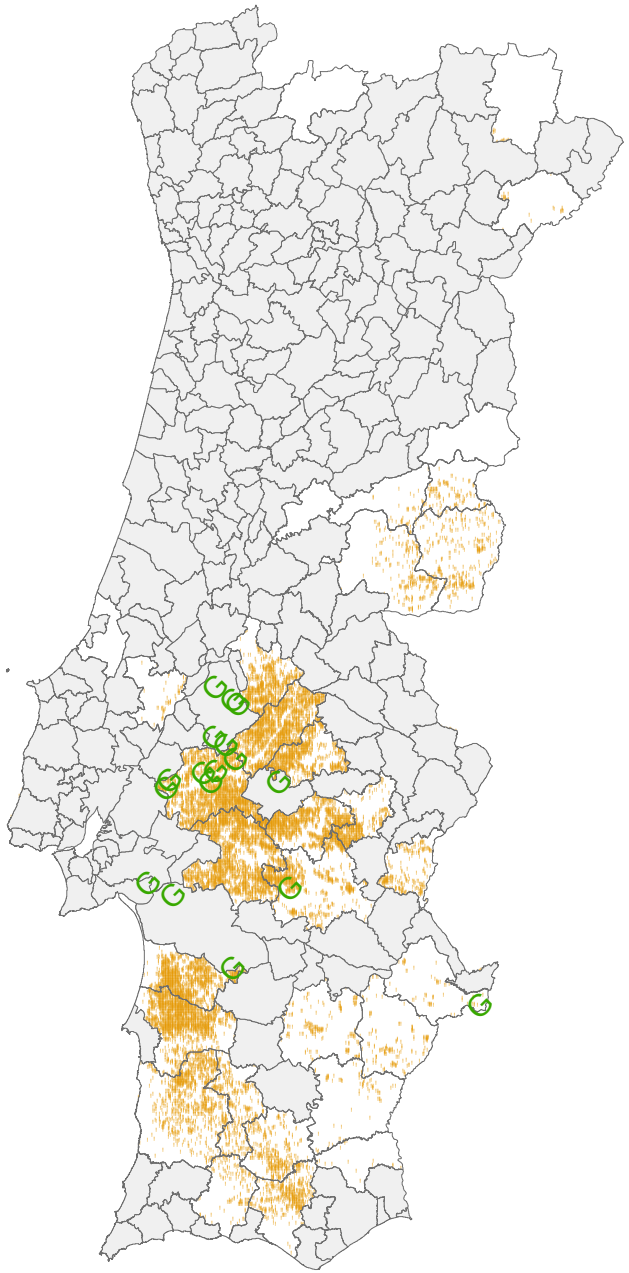
Plot distribution



100 permanent plots

	Machoqueira	Mitra	AGROREG	ICNF
Place	Chamusca	Évora	Alcácer do Sal Chamusca Coruche	Mora Moura
Installation date	1995	1997	2004	2006
Sampling design	Stratified			Stratified
Number of plots	67	1 + “1”	3 + 3 + 6	10 + 10
Plot Area	5000 m^2	3000 m^2	3000 m^2 to 20 000 m^2	3000 m^2
Debarking	Yes	Yes	Yes	No

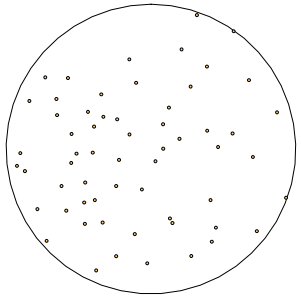
Machoqueira



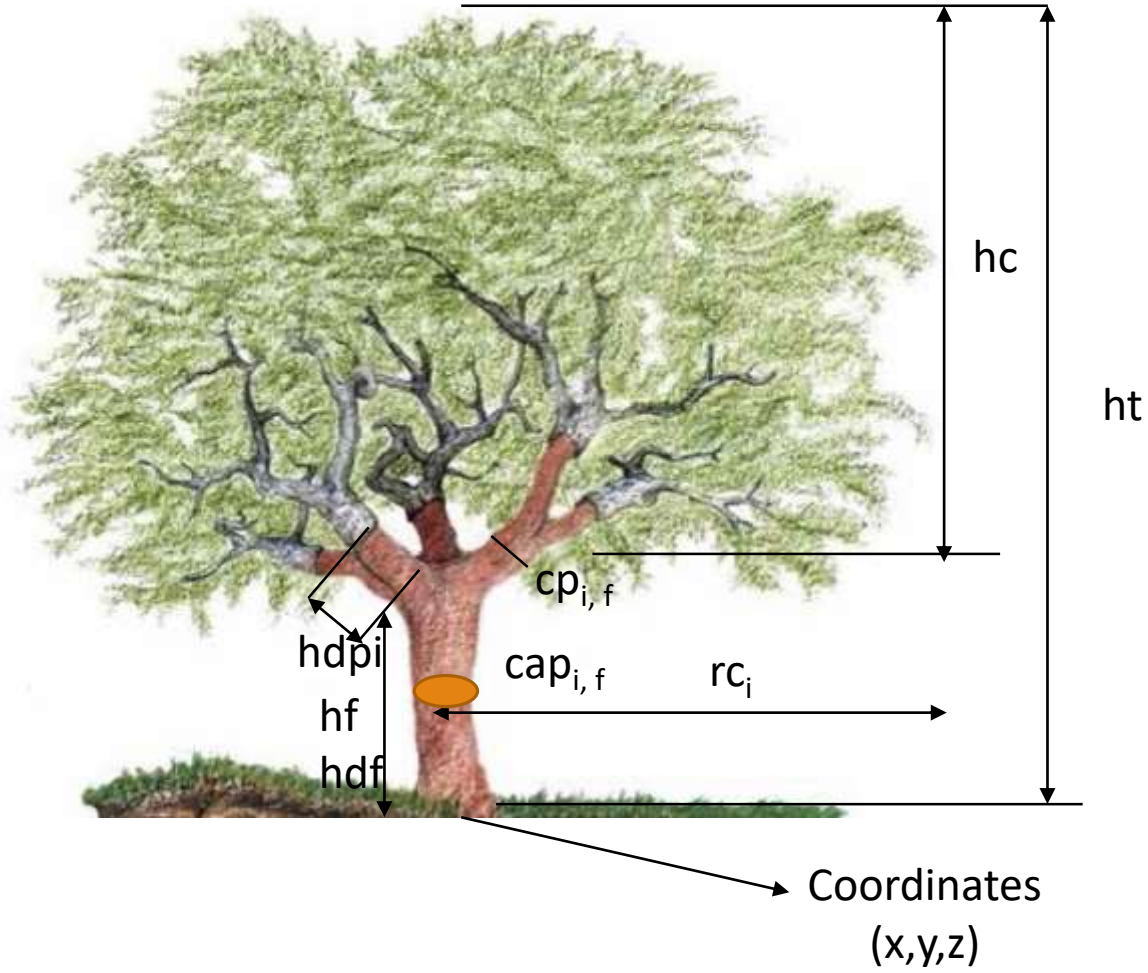
67 circular plots with 5000 m^2

Dendrometric data
Stand data

21 years
3rd measurement
3rd debarking



Tree variables

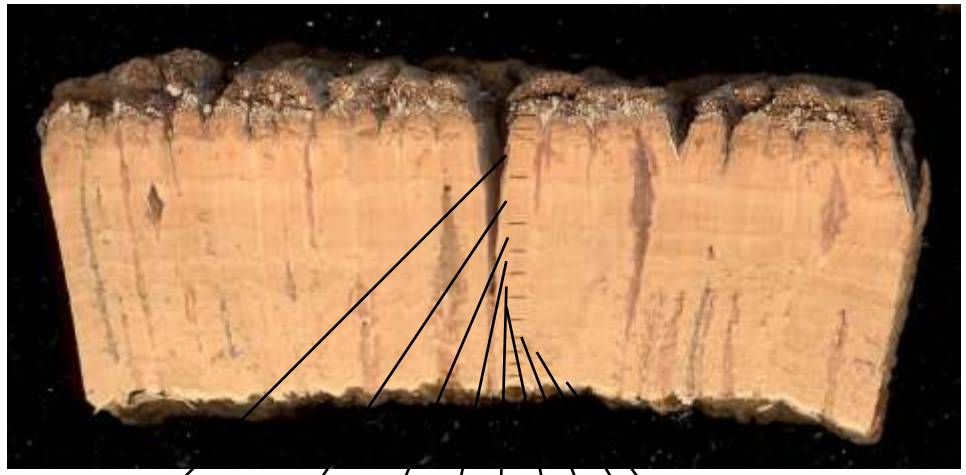


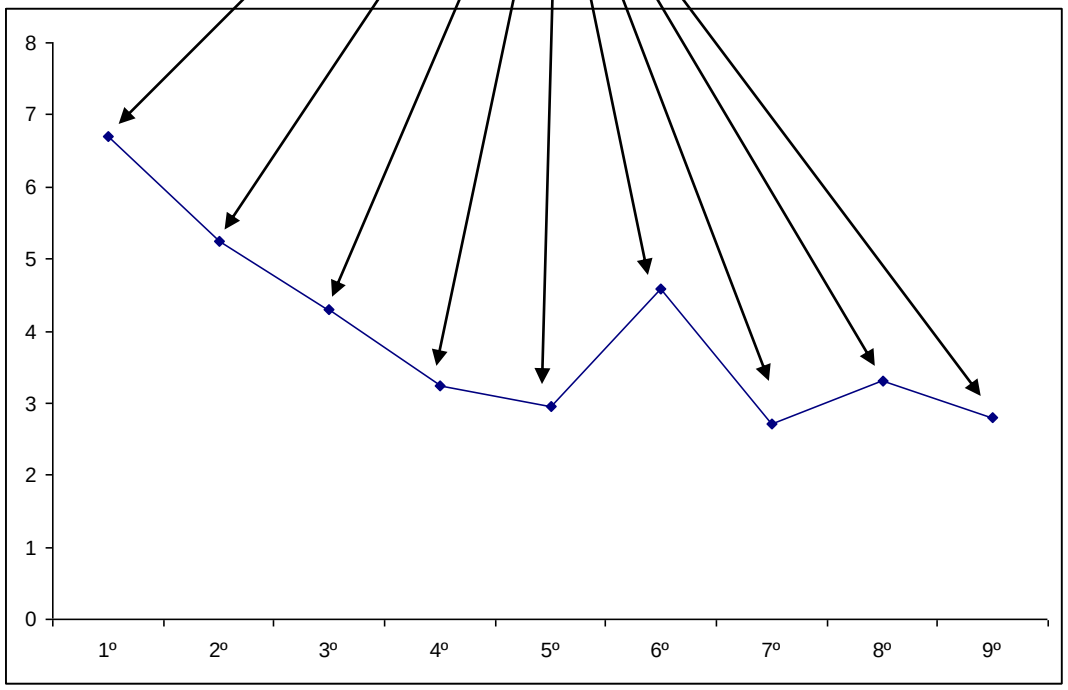
Cork

- Weight
- Moist
- Porosity
- Annual growth

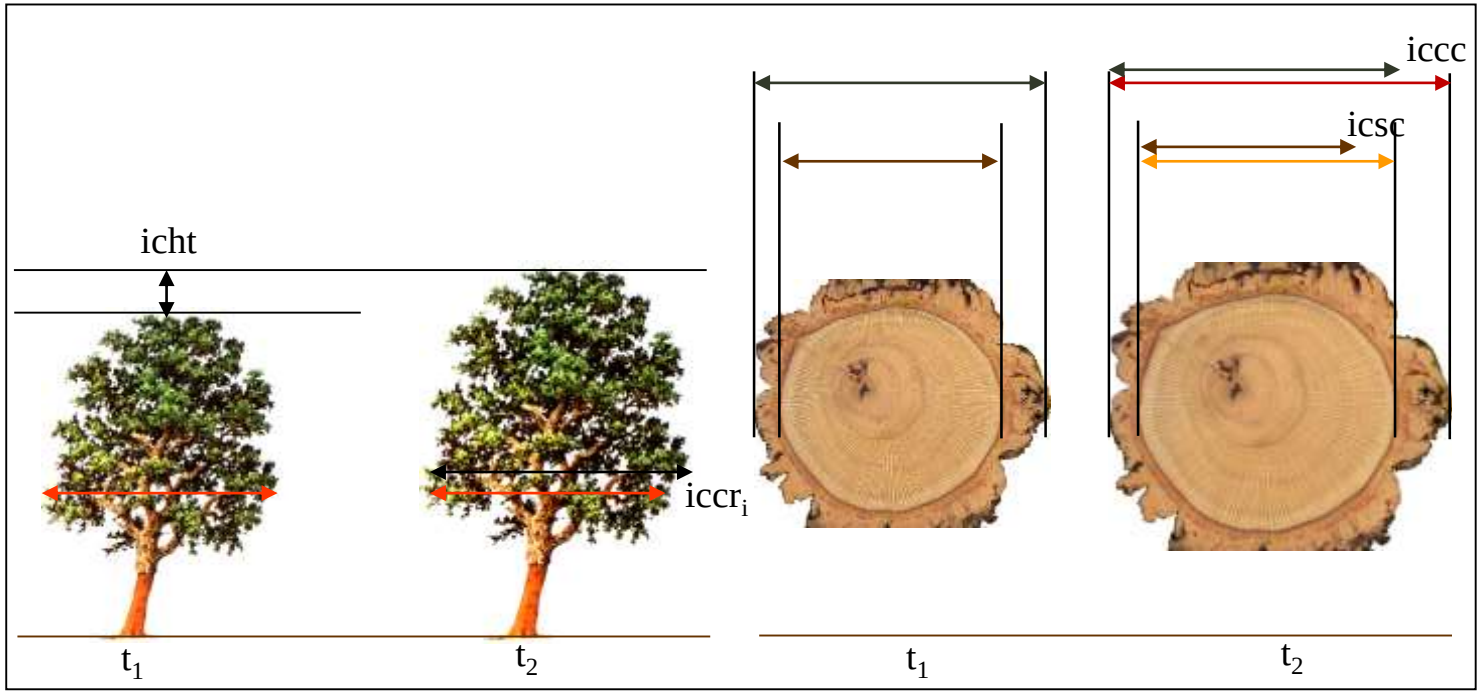
Tree growth variables: Cork

Digital image analysis of scanned cork sample in transversal cut





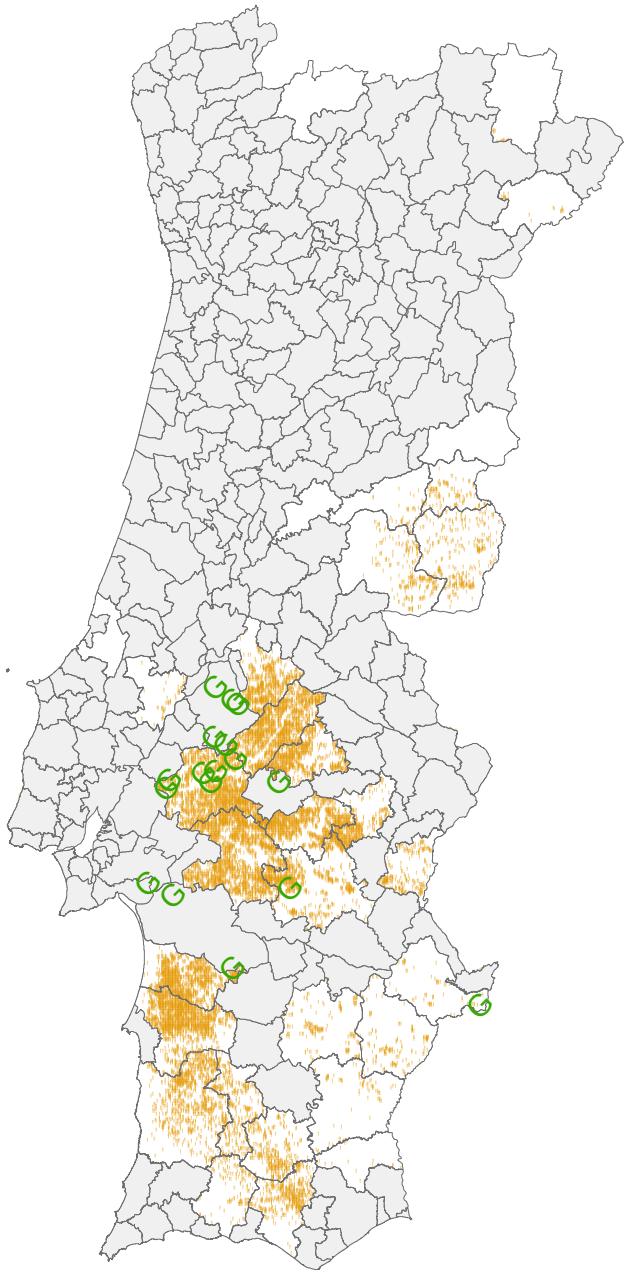
Increment in height, crown and stem obtained with repeated measures data:



Stand variables

Slope
Aspect
Soil profile
Soil chemical and physical analysis
Leaves chemical and physical analysis

Mitra



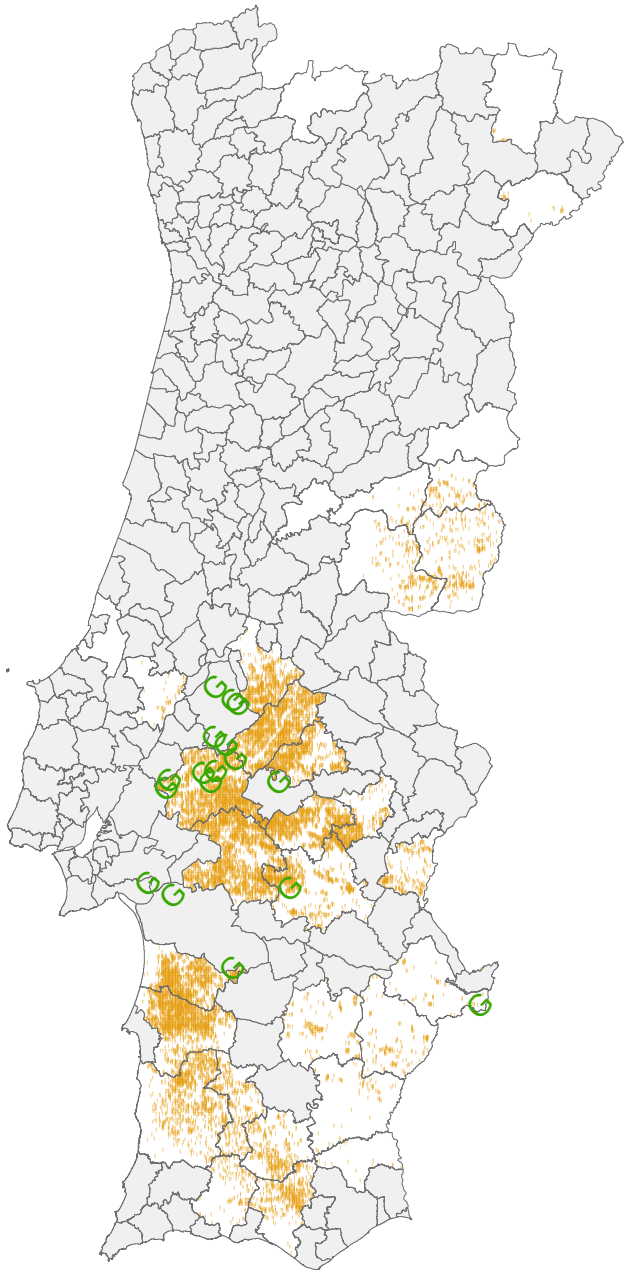
1 stand with 50 000 m^2

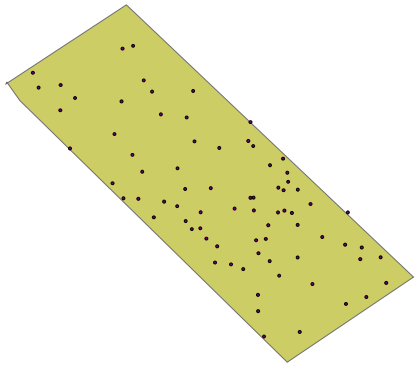
Dendrometric data
Stand data
Climatic data

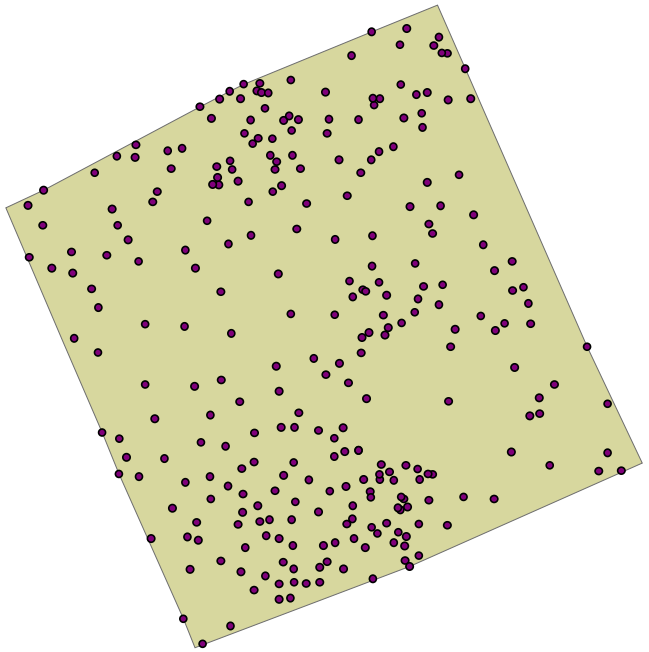
20 years
Annual census

1 plot with 3000 m^2

AGROREG

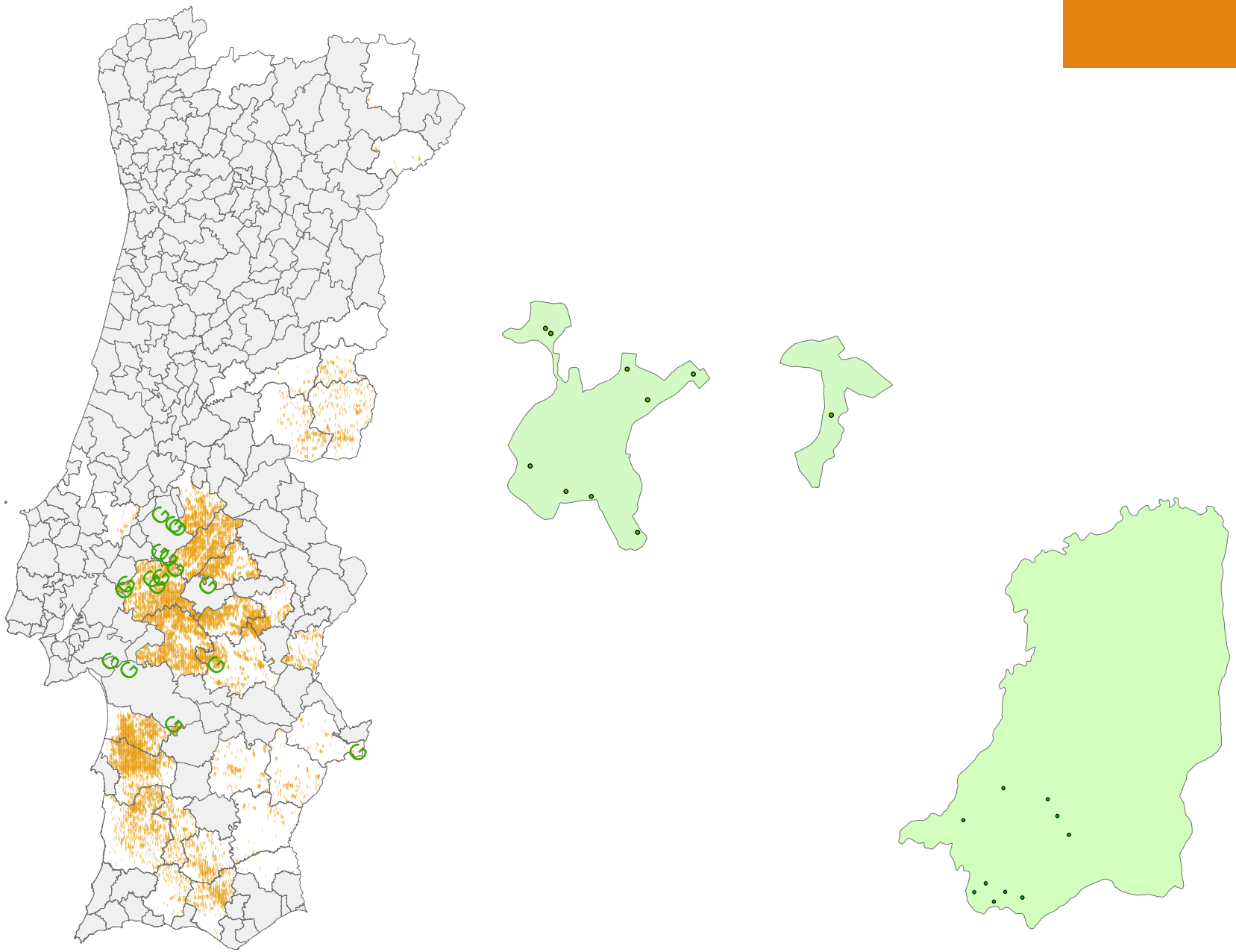






12 plots with variable shape and dimension, from 3000 m^2 to 20 000 m^2 over a topo-sequence

ICNF

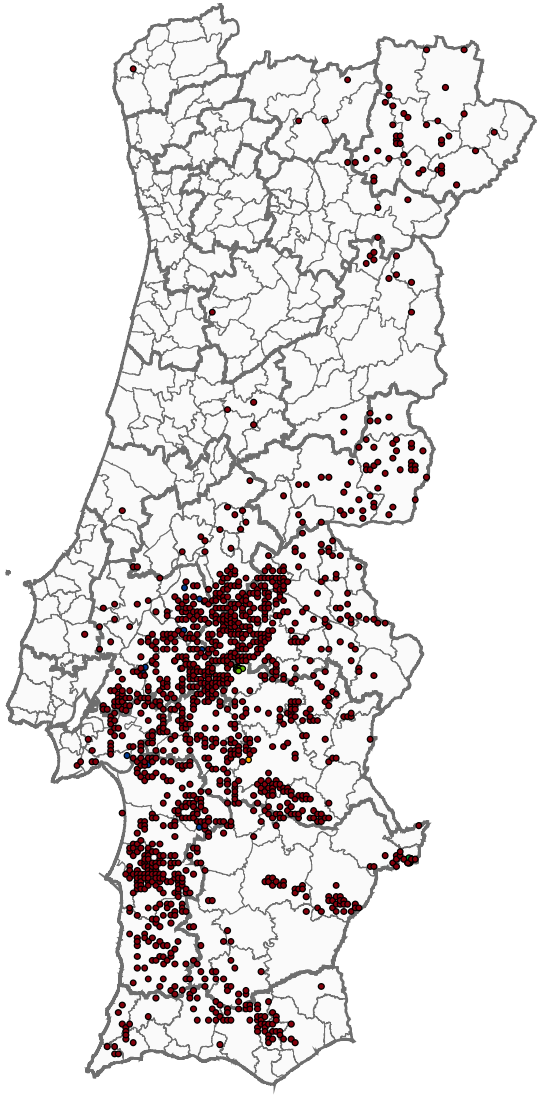


20 plots with 3000 m^2

Dendrometric data
Stand data

10 years
2nd measurment

National Forest Inventory



1284 circular plots with 2000 m^2