Food Availability by 2100, solvable or a human drama?

Impact of Demography & Climate Change

Raoul A. Weiler

WAAS Trento April 06, 2017

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- Project Diagram

1st Climate Classification System *Köppen-Geiger*

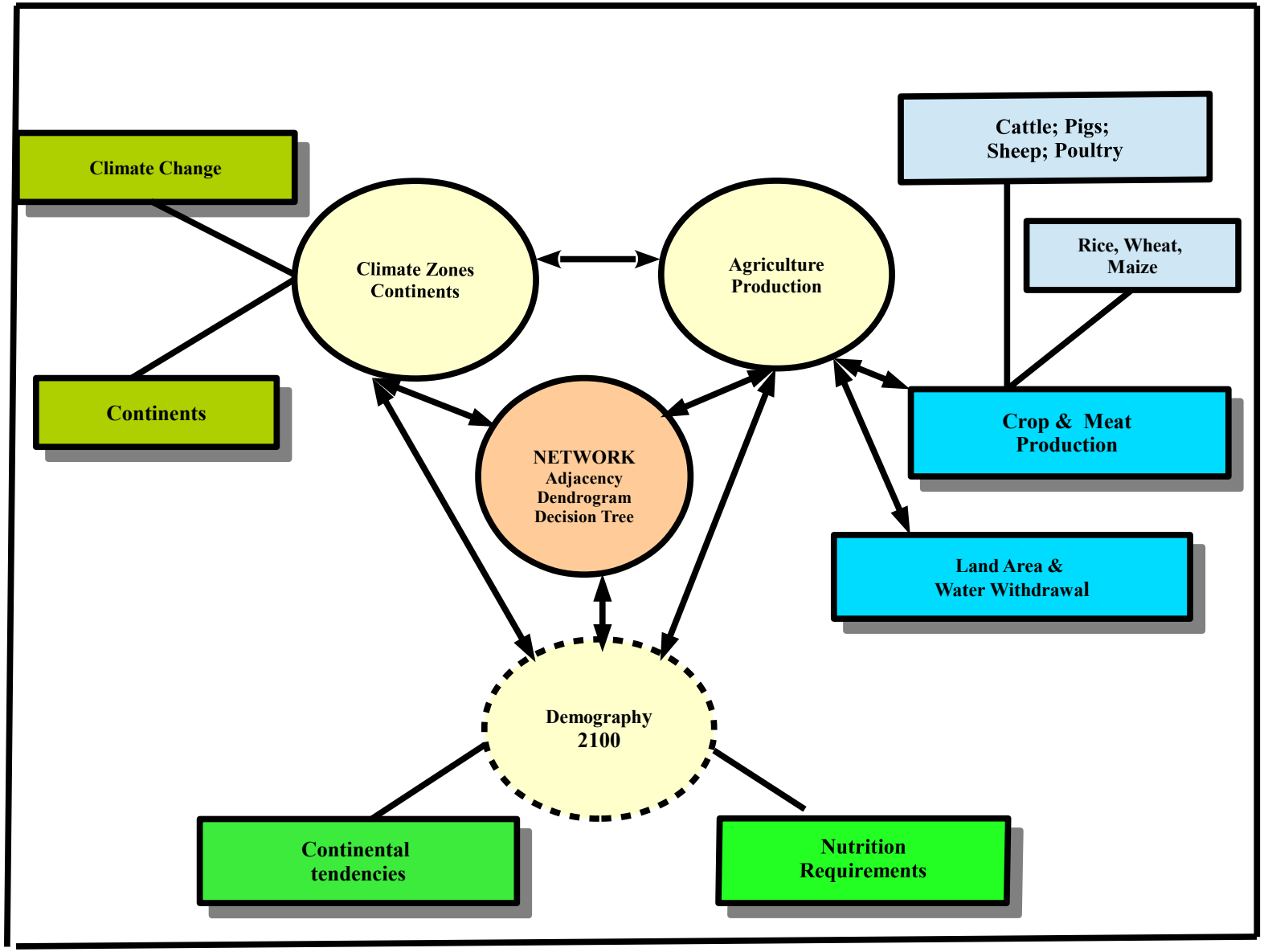
2nd *Demography*
Evolution from 1950 till 2300 and per continent

3rd *Science of Networks* applied to food elements:
- **Data : Crops/Meat/Agriculture resources**
- **Statistical analysis : *Gephi, R,* a.o.**

4th Impact of *Climate Change on food*. IPCC Reports

5th Recommendations. *World Governance Body*

Project Structure



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Food Scarcity
Unavoidable by 2100?

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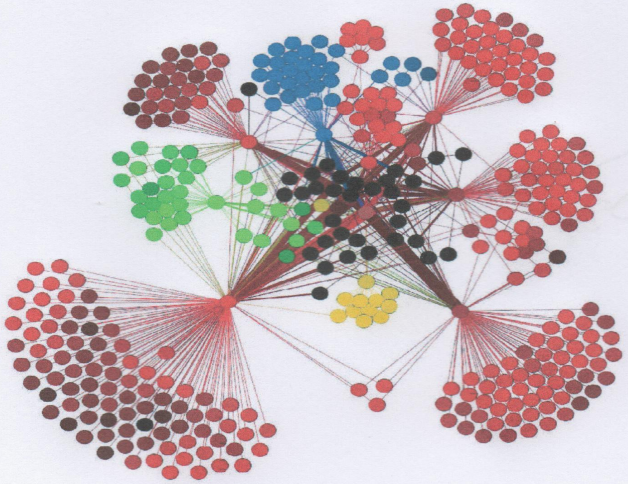

A Report to the European Academy of Sciences
and Arts, Salzburg, Austria

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Globethics.net

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Food Scarcity Unavoidable by 2100?

Impact of Demography & Climate Change

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1. Climate Classification System

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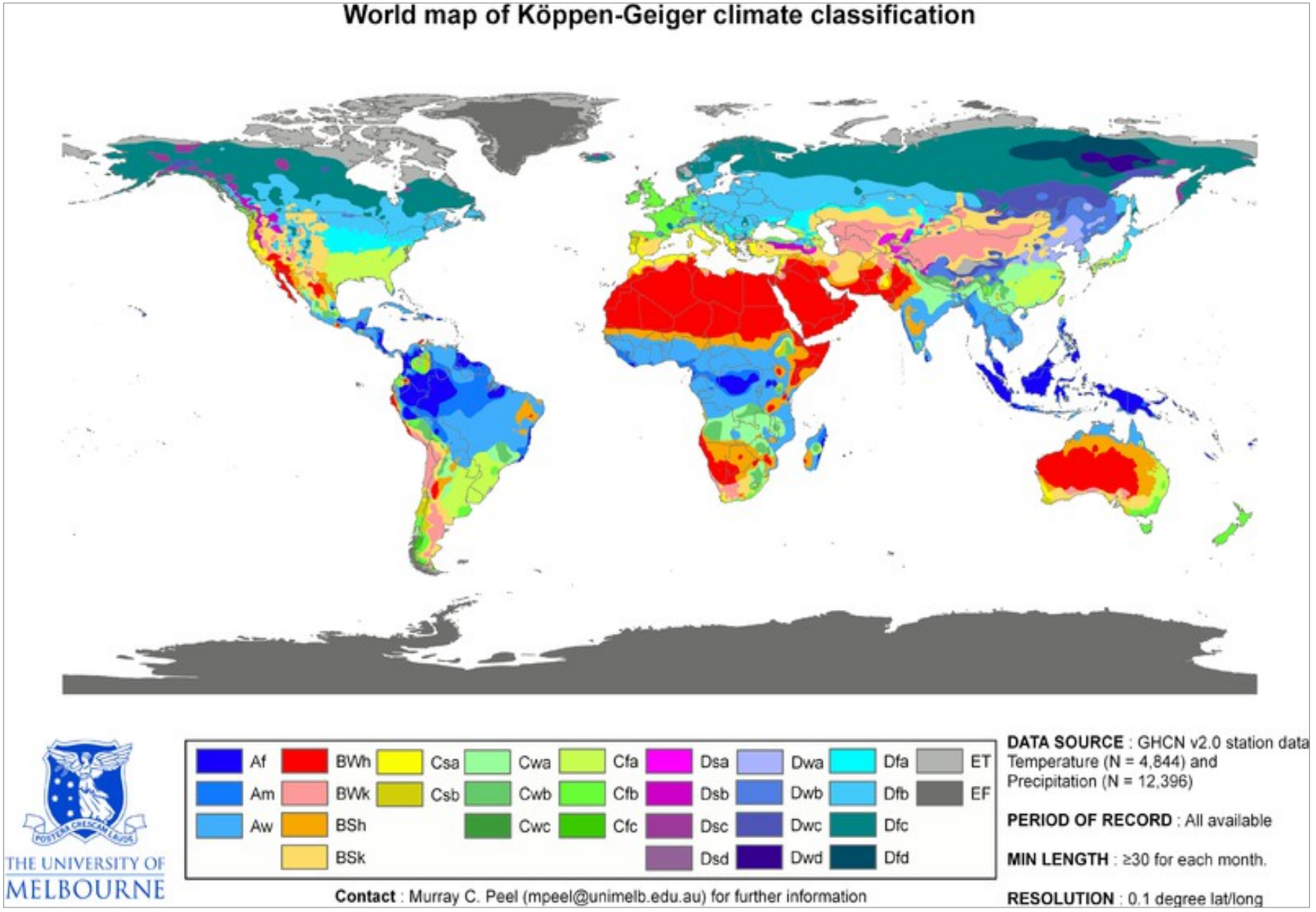
Köppen-Geiger Classification System



Climate Classes (5) and Climate Zones (25)

- 3 *A tropical* (Af, Am and Aw), {As}; lowest mean monthly air T =>18°C

- 4 *B arid (desert) & semi-arid* (Bwh, Bwk, Bsh and Bsk); the P_{ann} and T_{ann}, & annual cycle of precipitation

- 7 *C temperate* (Cfa, Cfb, Cfc, Csa, Csb, Cwa, Cwb), {Csc, Cwc}; lowest monthly mean −3°C< T> +18°C

- 9 *D cold* (Dfa, Dfb, Dfc, Dfd, Dsa, Dsc, Dwb, Dwc, Dwd), {Dsb, Dsd, Dwa}; the lowest mean T=< -3°C

- 2 *E polar* (ET and EF).highest monthly mean T =< +10°C

Total 25 CZs

Surface Distribution Climate Classes per Continent

Continent	A in % [Tropical]	B in % [Dry]	C in % [Temperate]	D in % [Conti-nental]	E in % [Polar]
Africa	31,0	57,2	11.8	-	-
Asia	16,3	23,9	12,3	43,8	3,8
Europe	-	36,3	17,0	44,4	2,3
Northern Am.	5,9	15,3	13,4	54,5	11,0
South America	60,1	15,0	24,1	-	0,8
Australia	8,3	77.8	13,9	-	-
Planet-glob.	19,0	30,2	13,4	24,6	12,8

2nd Demography 1950 – 2300

UN-Data

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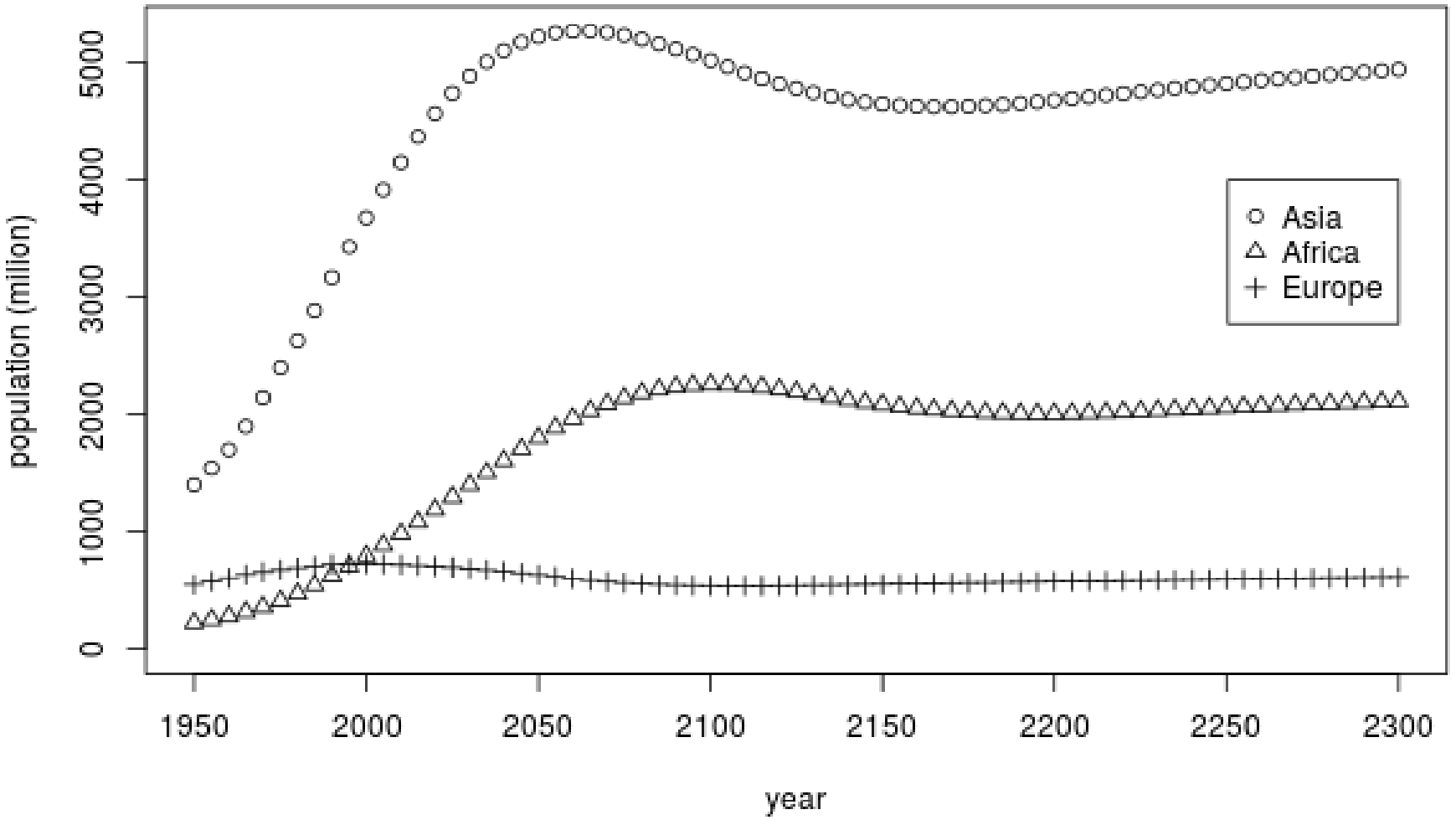
The demographic evolution of three continents



Population per Climate Class 2010

Climate Class	Description Climate	Population in billion
A	Tropical/megathermal	1.95
B	Dry -arid & semi-arid	1.96
C	Temperate/mesothermal	l.74
D	Continental/microthermal	1.22
E	Polar & alpine	0.058
Sum	Planet	6.928

Ratios of population growth different periods & continents

	Ratio 1950-2100	Ratio 2000-2100	Ratio 2010-2100
Africa	10.19	2.83	2.29
Asia	3.59	1.36	1.21
Europe	0.98	0.74	0.75
LatAm &Carib.	4.38	1.41	1.23
Northern Am	2.76	1.50	1.36
Oceania	3.60	1.49	1.32
World	***3.60***	***1.49***	***1.33***

3rd Network Application : Graphical Representation

Gephi **Open source Graphs**

R **Open source Language Analysis**

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Synthesis Crops & Meat Output per Climate Class

Climate Class	Population mio 2010	Crops		
		Rice 10^3tons 2010	Wheat 10^3 tons 2010	Maize 10^3 tons 2010
Sum *A*	1,947,030	301,116	41,054	131,395
Sum *B*	1,961,239	146,853	181,188	158,157
Sum *C*	1,745,263	165,102	196,972	256,014
Sum *D*	1,216,527	88,332	207,066	282,704
Sum *E*	58,009	530	17,863	14,788
Sum-CZ	*6,928,068*	*701,933*	*644,143*	*843,058*

Synthesis Crops & Meat Output per Continent

Continents	Population mio 2010	Crops			Meat			
		Rice 10^3tons 2010	Wheat 10^3 tons 2010	Maize 10^3 tons 2010	Beef 10^3 tons 2010	Pigs 10^3 tons 2010	Sheep+goat 10^3 tons 2010	Poultry 10^3 tons 2010
Africa	1,032,186	23,172	22,375	66,258	6,668	1,234	2,876	4,827
Asia	4,190,220	637,668	290,396	254,714	16,609	61,961	7,647	34,617
Europe	742,825	4,304	194,406	78,311	10,993	26,817	1,296	16,203
NAM	538,924	13,671	87,242	352,256	15,650	13,662	215	24,645
SAM	423,913	23,118	49,724	91,519	17,665	5,268	1,365	18,232
Sum-Conti	***6,928,068***	***701,933***	***644,143***	***843,058***	***67,585***	***108,942***	***13,399***	***98,524***

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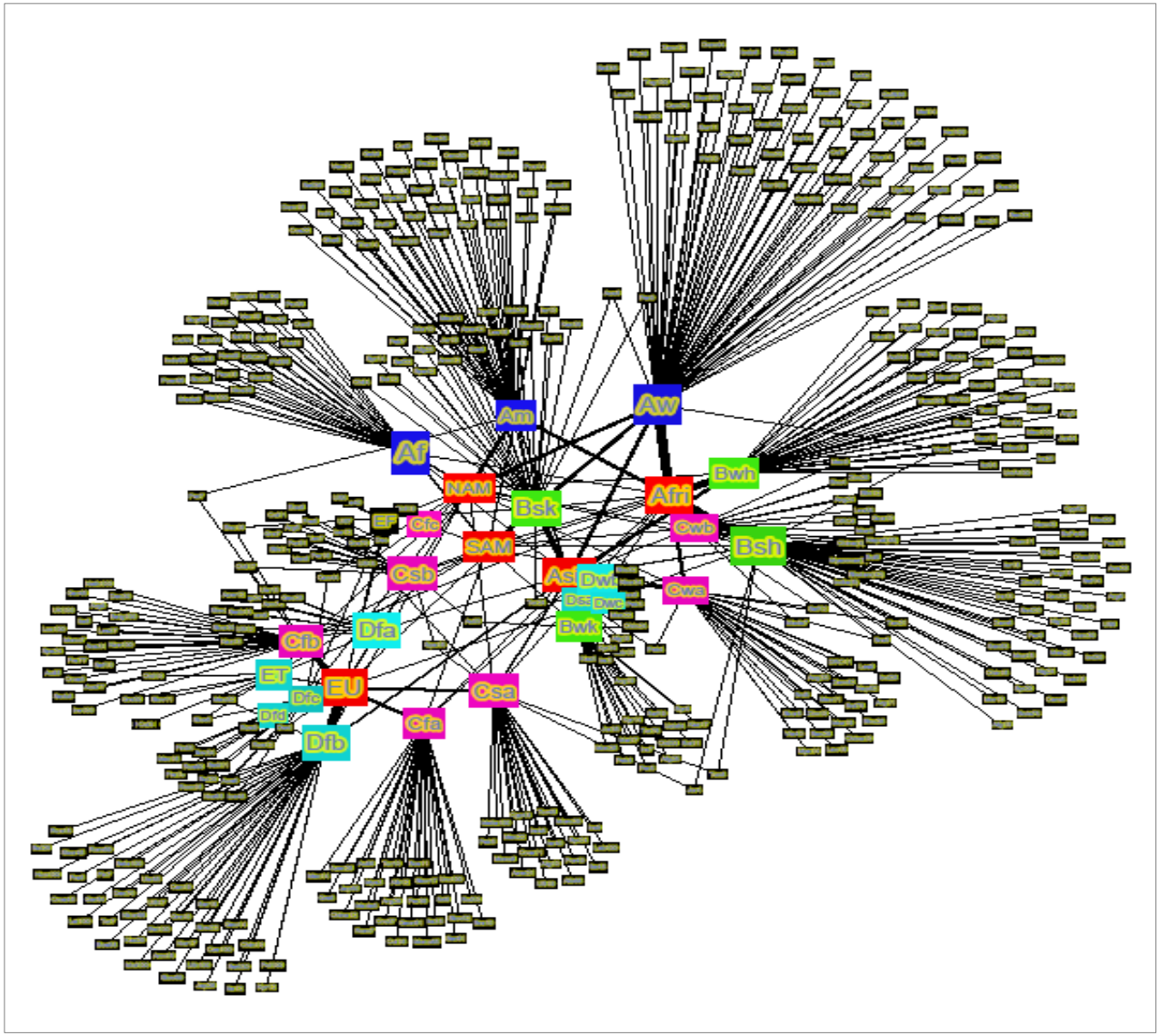
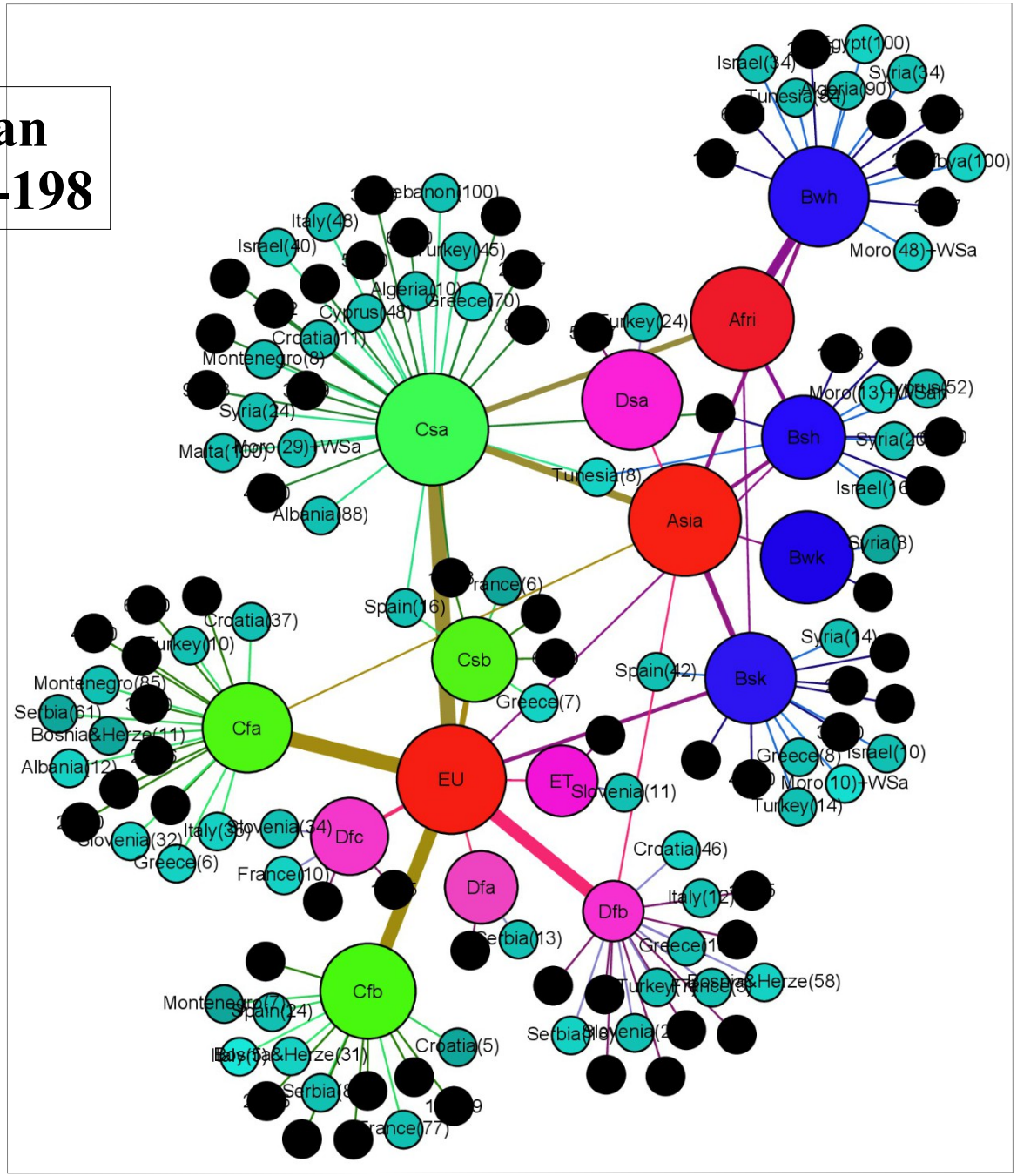
Network for Earth : Continents (5), CZs (25), Countries (150 &320 fractions), with 477 nodes & 543 edges (links)

Red Boxes: Continents 5

Blue : **A** Climate Class **3**
Green: **B 4**
Purple: C 7
Blue/green: D 9 + E 2



Mediterranean Agri-land, 144-198



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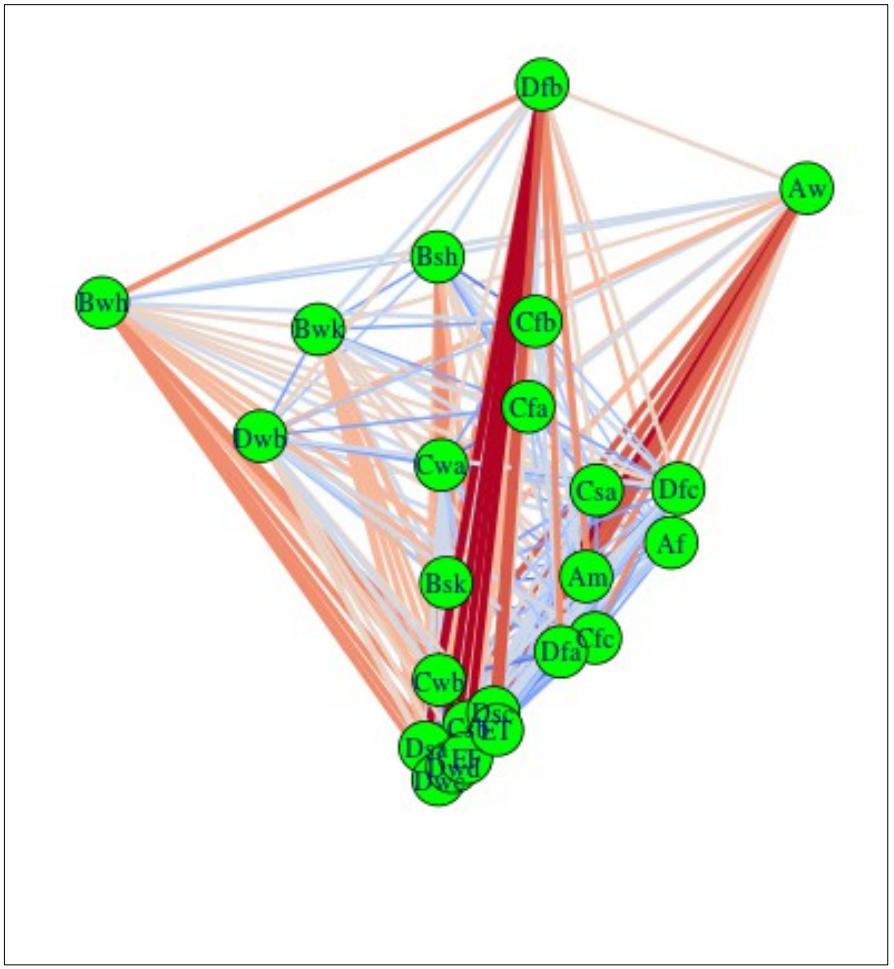
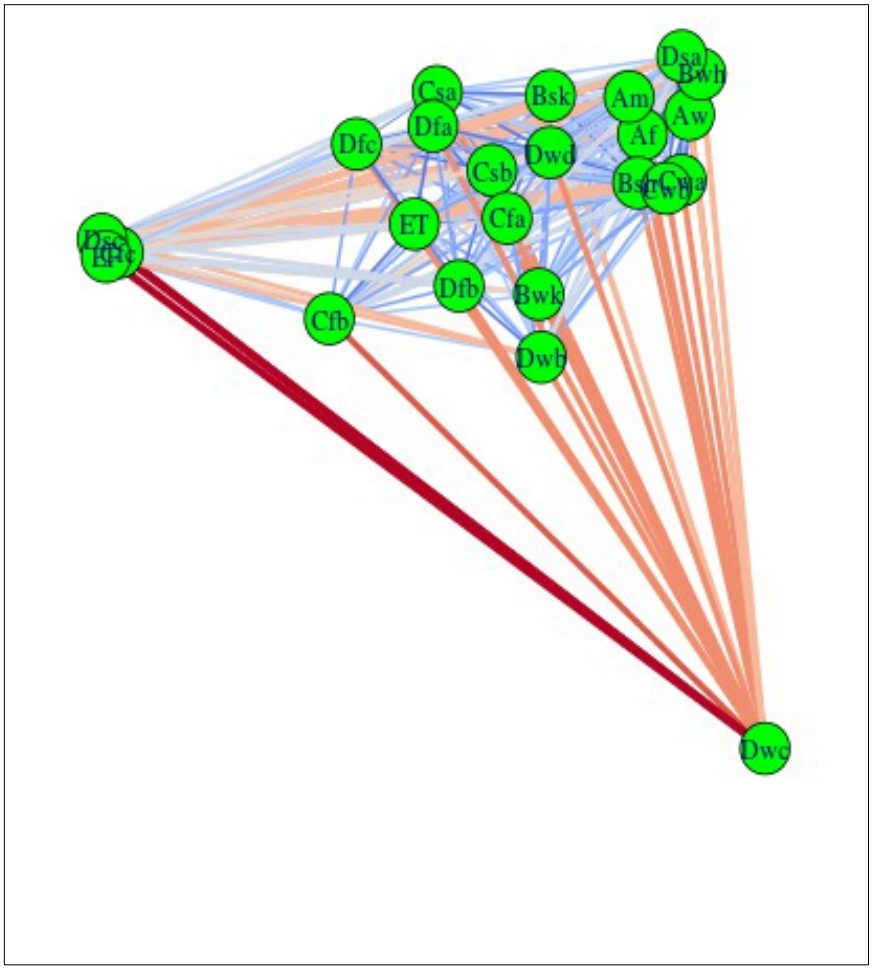
Defining Distances

- consider every row in the table as a point in a 4D space: beef, pigs, sheep-goat, poultry
- compute Euclidean distances between CZs result:

  - every CZ is positioned in 4D space
  - between every two CZs there is a distance
  - distance = dissimilarity between CZs with
  - respect to meat production
  - can be plotted in a graph

Kamada Kawai algorithm





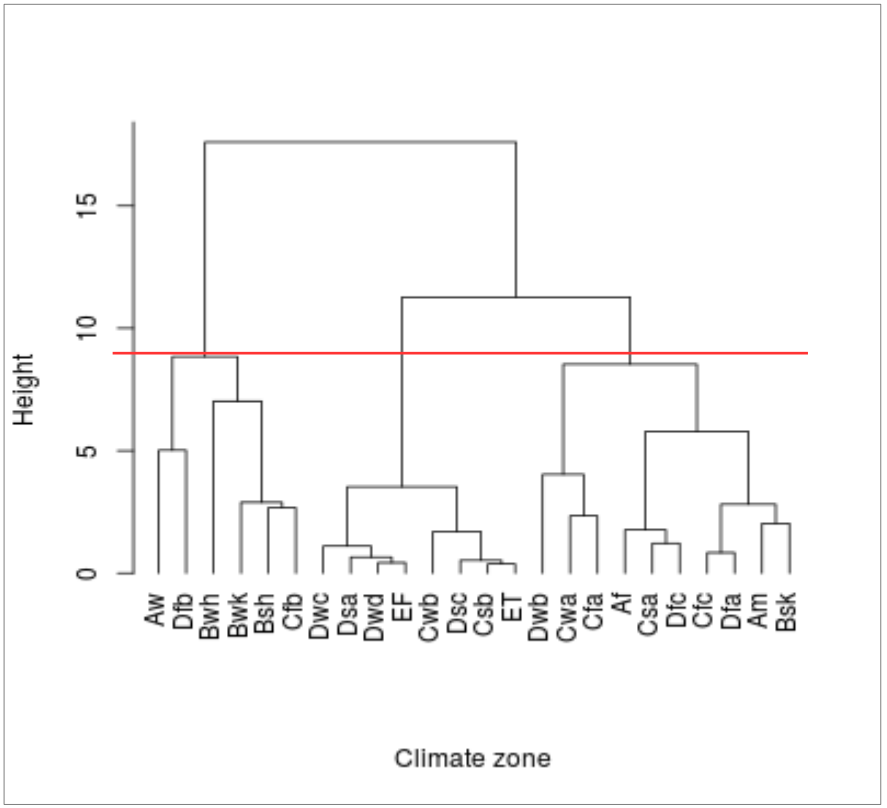
Meat Production

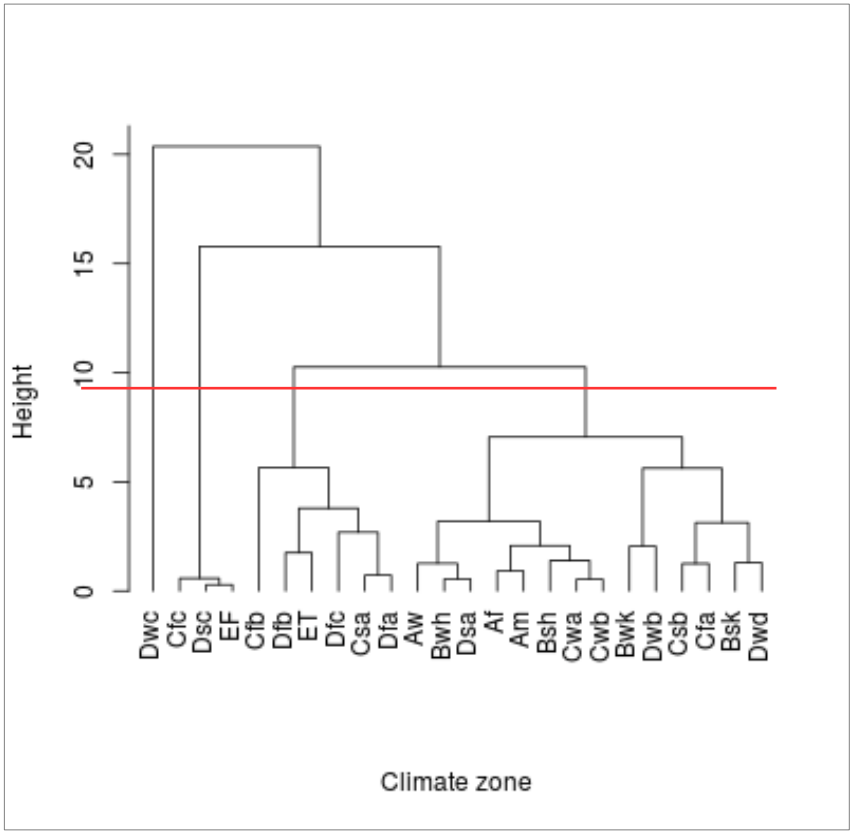
Meat Production per ca

FAO Rome March 24, 2017

Dendrogram

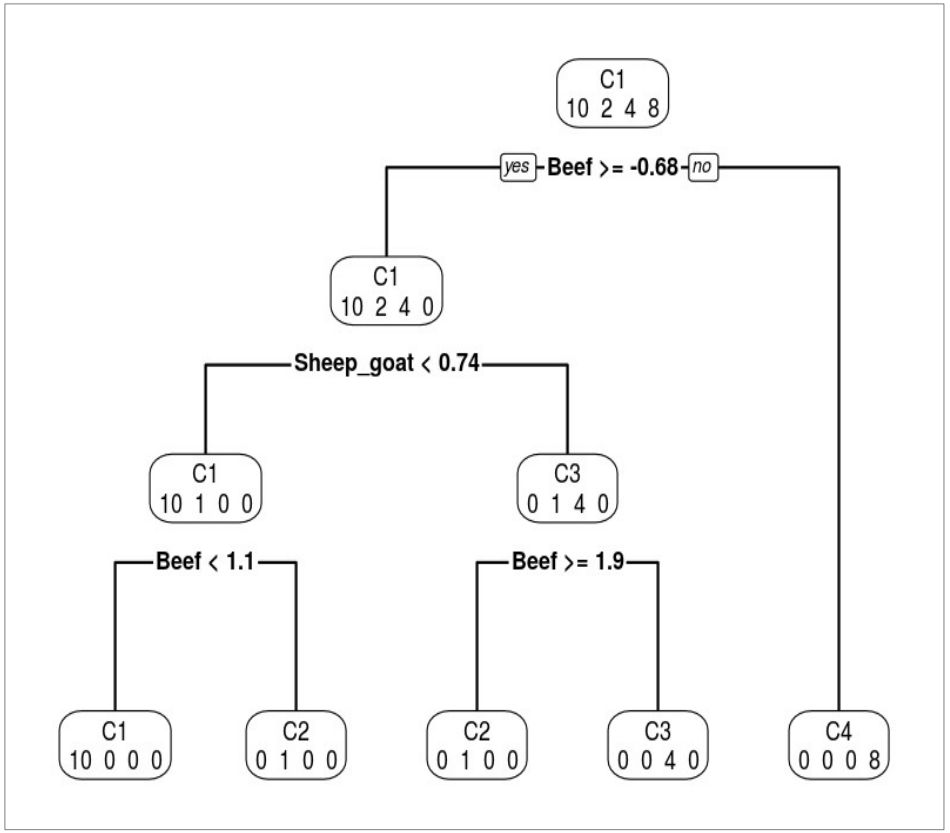
Dendrograms give insight in the connections between the CZs

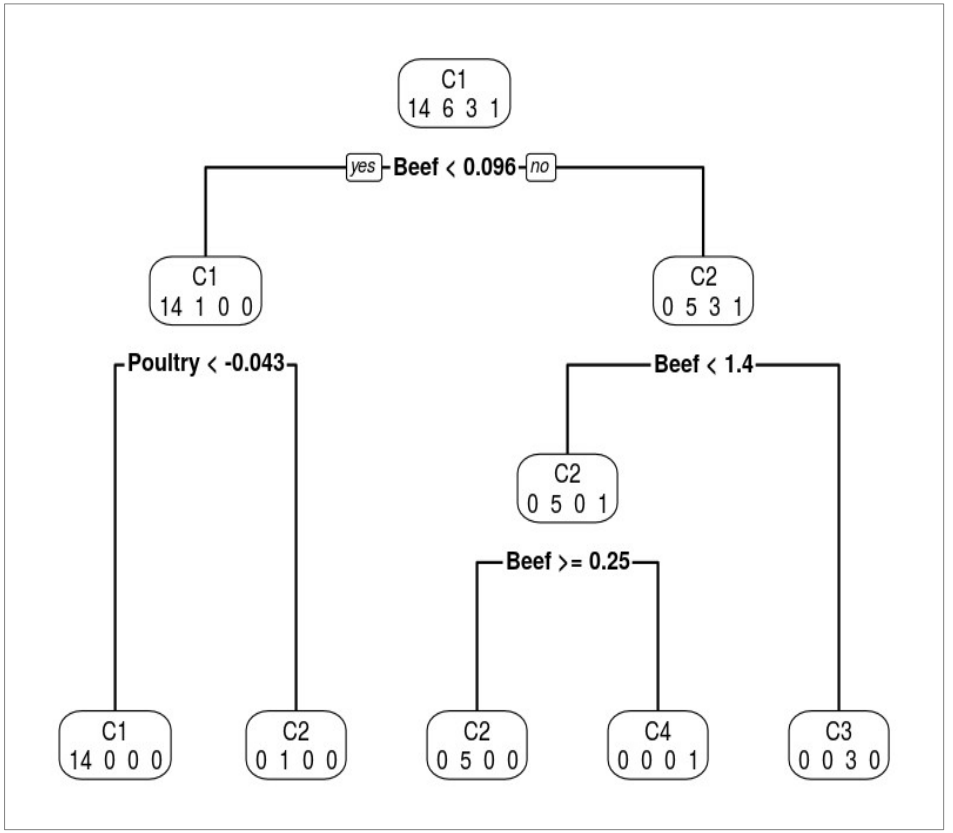




Decision Trees

- **beef production seems to be the main discriminator**





4th Climate Change. IPCC perspective

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From IPCC Reports & Other Publications

- Temperature Rise is continuous NOT a Step-function
[wrong 2°C, proclaimed in Media, by Politicians]

- Extreme weather conditions - climate variability
Negative effects on Crops production : Wheat & Maize,
Fresh water problem

IPCC AR4 (2000) *SRES*
Special Report on Emission Scenarios
Six *Story-lines* families A1 [A1F1 & A1F2], A2, B1, B2

IPCC AR5 (2014) *RCPs*
Representative Concentration Pathways

IPCC SRES A1F1 Scenario for Climate Classes

Köppen-Geiger Climate Class	Land Area*		Difference
	1976-2000 %	2076-2100 %	%
A	19.42	22.46	+3.04
B	29.14	31.82	+2.68
C	14.67	15.20	+0.53
D	21.62	19.48	-2.14
E	15.15	11.04	-4.11
SUM	100	100	0

* Rubel & Kottek

IPCC-AR5 *RCPs* T increase projections (°C)

	2046-2065	2081-2100
Scenario	Mean °C and *likely* range	Mean °C and *likely* range
RCP2.6	1.0 (0.4 to 1.6)	1.0 (0.3 to 1.7)
RCP4.5	1.4 (0.9 to 2.0)	1.8 (1.1 to 2.6)
RCP6.0	1.3 (0.8 to 1.8)	2.2 (1.4 to 3.1)
RCP8.5	2.0 (1.4 to 2.6)	3.7 (2.6 to 4.8)

IPCC Comments/Findings #2

Some common 21st century changes across all models:

- **frost climates are largely decreasing,**
- **some arid regions are increasing,**
- **large fraction of land-area changes cool to hot summers.**

Almost all land areas of the northern *middle* and *high* latitudes undergo climate shifts; tropical regions not many.

Most changes obtained here seem to be *temperature* rather than *precipitation* driven.

High heat stress could turn tropical regions into *uninhabitable* regions for mammals; global mean temperature increase of 7°C.

5th Food Production. Recommendations.

- Creation of World Governance Body

- Food Production increase : 8 proposals

The Existential Priority of the Human Species

Allocating the *highest priority* to planetary agriculture.
Its priority *cannot* be disconnected from :
planetary Climate Change remediation,
availability of fresh water and fertilizer resources

and

a specific *world governance body for investment in agricultural production* should be envisioned, in order to avoid *massive social unrest* and *political instability* in several regions on Earth and over several decades to come.

Quoting *Norman Borlaug*

Scientific American **September 14, 2009**

"… civilization as it is known today could not have evolved, nor can it survive, without an adequate food supply...”

"The first essential component of social justice is adequate food for all mankind.”

Conclusions/Recommendations

Some Recommendations for Avoiding Food Scarcity by 2100

1. **Improve *management* of *fresh water*, *biological soil quality*, *use of fertilizer***

2. **Convert *land for meadows* to land for *crops***

3. **Breeding. *Norman Borlaug* on wheat. 'Green Revolution' Nobel Prize for Peace**

4. **GMO *endogenous* rather than exogenous intervention**

Conclusions/Recommendations

5. ***Photosynthesis*** **from C3 to C4, reducing water needs & improved resilience to drought : *case of rice***

6. ***Industrialization*** **of animal husbandry**

7. **Africa. Massive investment in *small sized machinery* and *Capacity Building*, at local level**

8. **If not : severe *social unrest* and *political instability***

THANK YOU

All persons have the right to have enough daily food for themselves and their families.

OPTIMISM IS NOT ENOUGH !!!!

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