BASQUE CENTRE
FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

ARIES

ARtificial Intelligence for Ecosystem Services

Training Caravan: Getting into Science

Elena Pérez-Miñana
Basque Centre for Climate Change (BC3)
Bilbao

EUSKO JAURLARITZA GOBIERNO VASCO
INGURUMEN ETA LURRALDE ANTOLAMENTU SAILA
DEPARTAMENTO DE MEDIO AMBIENTE Y ORDENACIÓN DEL TERRITORIO

EUSKO JAURLARITZA GOBIERNO VASCO
HEZKUNTZA, UNIBERTSITATE ETA IKERKETA SAILA
DEPARTAMENTO DE EDUCACIÓN, UNIVERSIDADES E INVESTIGACIÓN

Universidad del País Vasco Euskal Herriko Unibertsitatea

ikerbasque
Basque Foundation for Science

ihobe

Outline

- My Career Path
  - How I got here?
- BC3 (Basque Centre for Climate Change)
  - What do we do at BC3?
  - What do I research?
- A Day of Research
- Getting into Science
  - What is Science?
  - Why become a Scientist/Researcher?
  - What you Need?

BASQUE CENTRE
FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

ARIES

ARtificial Intelligence for Ecosystem Services

How I got here?

EUSKO JAURLARITZA
GOBIERNO VASCO
INGURUMEN ETA LURRALDE ANTOLAMENTU SAILA
DEPARTAMENTO DE MEDIO AMBIENTE Y ORDENACIÓN DEL TERRITORIO

EUSKO JAURLARITZA
GOBIERNO VASCO
HEZKUNTZA, UNIBERTSITATE ETA IKERKETA SAILA
DEPARTAMENTO DE EDUCACIÓN, UNIVERSIDADES E INVESTIGACIÓN

Universidad del País Vasco
Euskal Herriko Unibertsitatea

ikerbasque
Basque Foundation for Science

ihobe

My Path

- Born: Madrid (Spain)
- School (Baccalaureate): Mérida (Venezuela)

- University (CS): Caracas (Venezuela)
- University (MSc, PhD): Edinburgh (Scotland)

} 12 Years

- R&D: Redhill, Basingstoke (England)
- Research: Wales
- Research: Guildford (England)

} 15 Years

- Research: Bilbao (BC3)

} Since July 2012

School Days

- Go to School: to have fun, see Friends, Swim, enjoy Outdoor activities
- but, Have to go to Classes & Need to Pass

- Bad at Studying Languages (Grammar)
- Good at Mathematics, History & Geography
- Interested: Good Teachers (Maths, Physics)
- Class Participation: Questions and Jokes

- 16/17: What Next? Not Sure
- University: because
  - Fulfill family expectations and ---
  - A good opportunity to get away from the Family and live “my own life”

My Path

- Born: Madrid (Spain)
- School (Baccalaureate): Mérida (Venezuela)

- University (CSE): Caracas (Venezuela)
- University (MSc, PhD): Edinburgh (Scotland)

} 12 Years

- R&D: Redhill, Basingstoke (England)
- Research: Wales (Aberystwyth)
- Research: Guildford (England)

} 15 Years

- Research: Bilbao (BC3)

} Since July 2012

University Days: Under-Graduate

- Studied Computer Science Engineering:
- Only 10 Hours of Class per Week: Meant to read a lot of Books

- Away from Home: Caracas
- Like a Holiday Camp: Friends, Drink, Sports...

- But, Need to Pass
- Exams: Finally Read & Learnt (CS)

- What Next? Not Sure
- University opportunity but …More Studies

My Path

- Born: Madrid (Spain)
- School (Baccalaureate): Mérida (Venezuela)

- University (CSE): Caracas (Venezuela)
- University (MSc, PhD): Edinburgh (Scotland)

} 12 Years

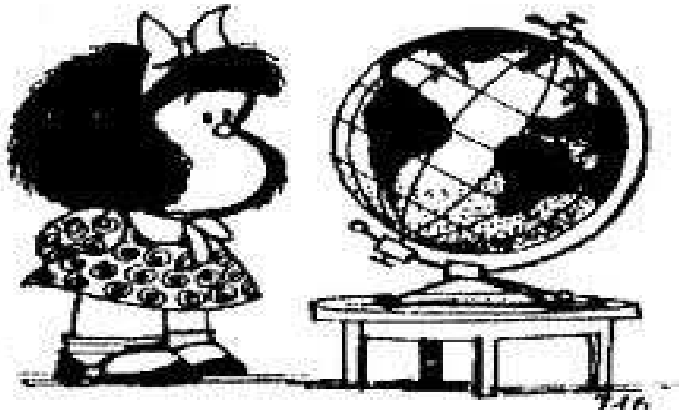
- R&D: Redhill, Basingstoke (England)
- Research: Wales (Aberystwyth)
- Research: Guildford (England)

} 15 Years

- Research: Bilbao (BC3)

} Since July 2012

University Days: Post-Graduate



- Studied Information Technology and Artificial Intelligence
- Started to work harder: More Inspired/More Interested

- Questioning What I Read
- Proposing New Ideas
- Publishing Papers in Journals

My Path

- Born: Madrid (Spain)
- School (Baccalaureate): Mérida (Venezuela)

- University (CSE): Caracas (Venezuela)
- University (MSc, PhD): Edinburgh (Scotland)

} 12 Years

- R&D: Redhill, Basingstoke (England)
- Research: Wales (Aberystwyth)
- Research: Guildford (England)

} 15 Years

- Research: Bilbao (BC3)

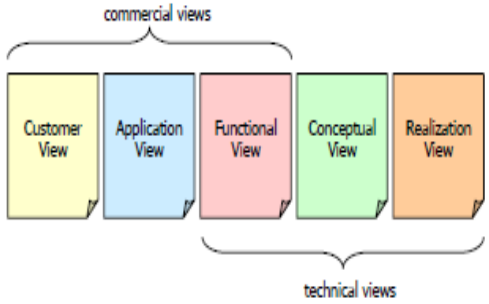
} Since July 2012

Research Days

- Slightly better paid and less uncertain
- Easier to obtain funding

- Applied Research was more useful
- Research results demanded quick return to Company

- Lucky: Found opportunity to merge Work with other Personal Interests
- Opportunity to Apply Modelling Techniques on Environmental Problems



MOTOROLA

PHILIPS

My Path

- Born: Madrid (Spain)
- School (Baccalaureate): Mérida (Venezuela)

- University (CSE): Caracas (Venezuela)
- University (MSc, PhD): Edinburgh (Scotland)

} 12 Years

- R&D: Redhill, Basingstoke (England)
- Research: Wales (Aberystwyth)
- Research: Guildford (England)

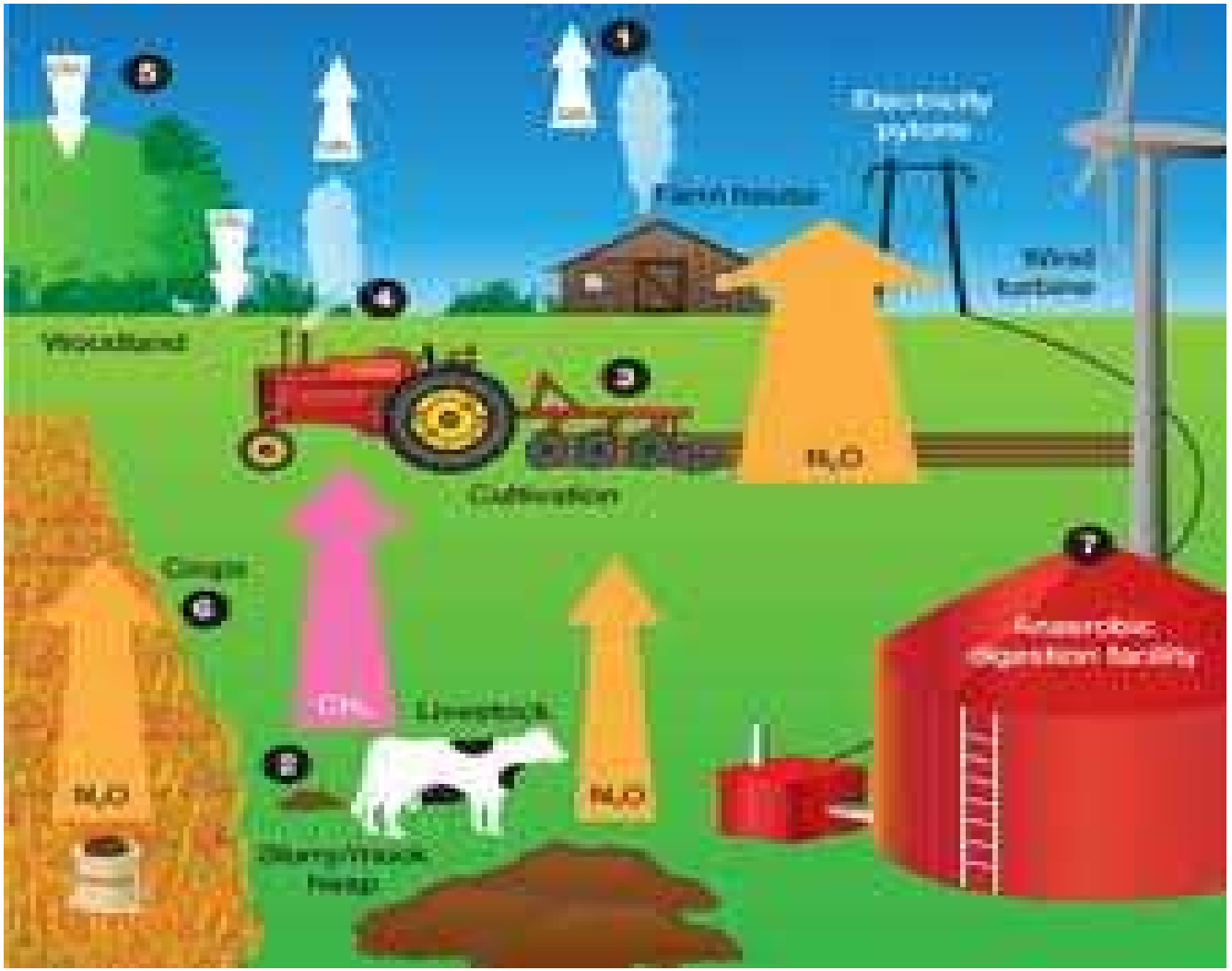
} 15 Years

- Research: Bilbao (BC3)

} Since July 2012

Sources of GHG emissions on a Farm

1. Wood burning
2. Cattle manure
3. Tractor fuel
4. Carbon capture by grass
5. Carbon capture by trees
6. Nitrogen from fertiliser
7. Anaerobic digestion

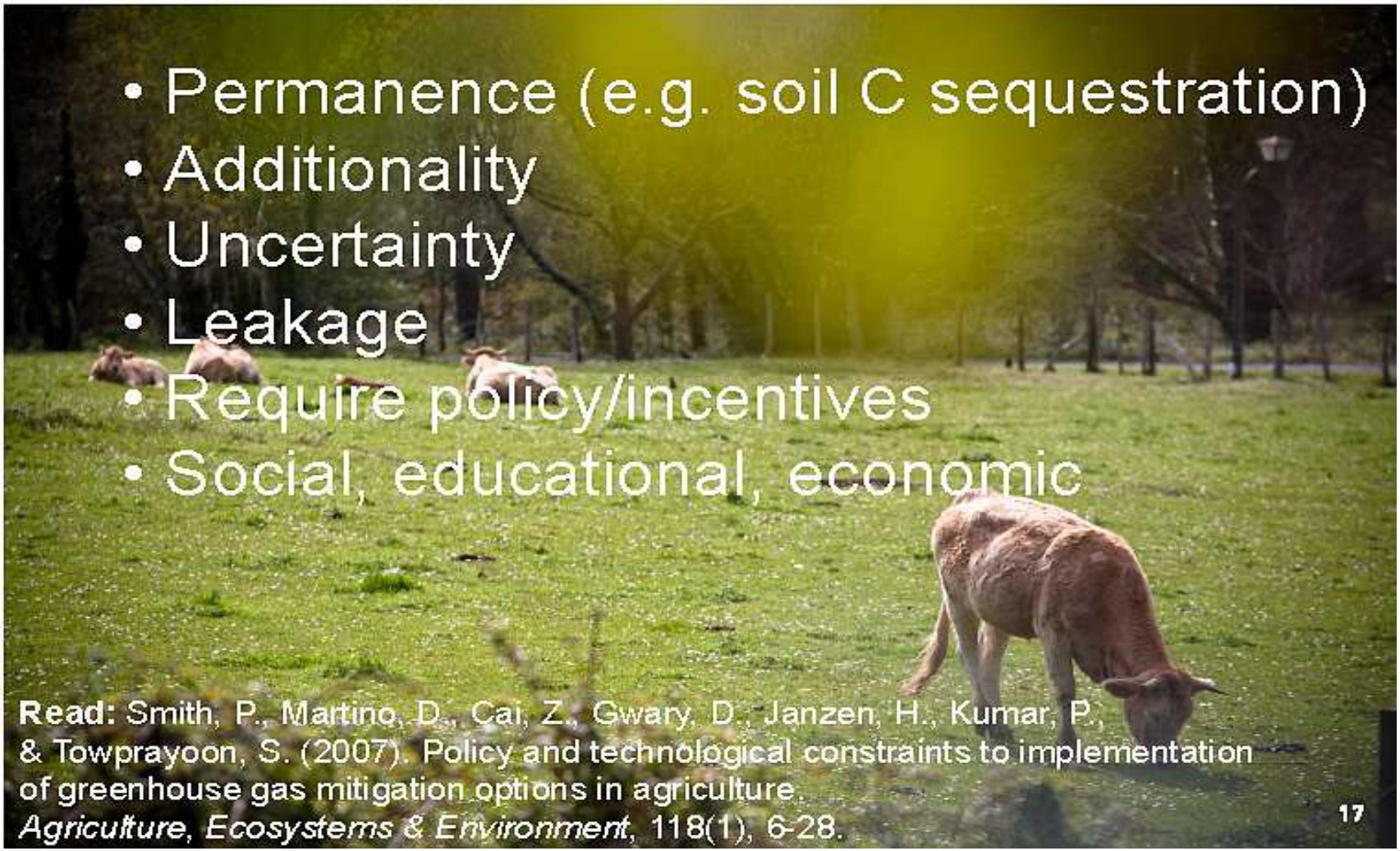


How can agriculture mitigate GHG emissions?(1)

- Reducing emissions
  - Cropland management
  - Livestock and manure management
  - Bioenergy
- Enhancing removals
  - Improving soil carbon sequestration
  - Main potential: C sequestration in cropland/grassland has been estimated to be 11-17% of total mitigation potential
- Avoiding (or displacing emissions)
  - Using land to grow crops for biofuels instead of using the land to grow food
  - This aspect has not been properly developed in the Kyoto Protocol

(1) Del Prado 2013

Barriers of implementation to the implementation of GHGe mitigation measures



Source: Del Prado, 2013. Potential options for mitigation of climate change from agriculture

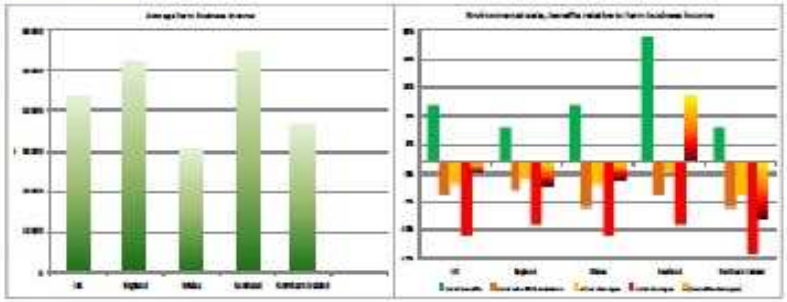
Bayesian Networks to support Greenhouse Gas Emission reduction in the Agricultural Sector (BaNGAS)

July 2010

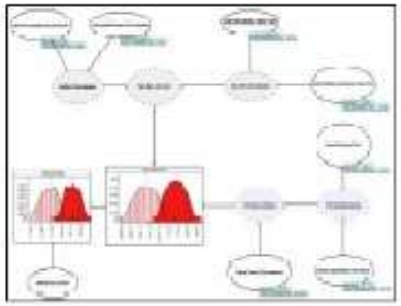
BaNGAS is a research project, launched as a KTA by the University of Surrey. It aims to support Farm Carbon's efforts to assist farmers in finding cost-effective means of achieving the reduction of GHG emissions in their farm activities. This aim will be achieved by:

- Generating estimates of the farm's environmental account using the methodology currently advocated by DEFRA, and used to produce the UK agricultural sector's annual report.
- Giving the farmers more cost effective ways of advancing their efforts to meet the rigorous requirements set by current government policies. This is achieved through the generation of different emission reduction scenarios the farm can deploy, together with the cost implications linked to each of them.
- Giving the farmers an outline of the cost and benefits associated to each of the environmental management activities currently carried out on the farm, and how they relate to the specific costs triggered by the GHG emissions produced on the farm. All this enables the farmers to conduct a more informed decision making process when designing the farms' production activities.

The cost implications that come as a result of the GHG emitted by an average farm can be seen in the plots shown below.



The plot on the left presents the annual business income of a farm in each country of the UK (data derived from DEFRA's 2008 UK Agriculture report). The plot on the right shows the environmental costs and benefits associated to an average farm relative to the business income. They illustrate a clear economic impact to the farm as a result of deploying, or not as the case may be, environmental measures. It also shows that the costs resulting from GHG emissions are an important component of the overall costs associated to the environmental damages that result from the farm's activity.



The graph on the left shows the GHG emissions produced by two farms, the red distribution corresponds to an estimate of the emissions produced by a mixed farm, the pink distribution are the emissions of the same farm powered by renewable energy. Although there is an important reduction on the total volume of emissions if the farm were to change to renewables, the cost implications can make the option impractical. Looking at alternative scenarios for the same farm, the pie-chart on the right, shows that it is possible to achieve a 25% reduction on the farm's emissions by deploying different land management measures, i.e. through a 15% reduction on the use of fertilisers, a 49% increase in the level of carbon sequestered through appropriate LUC practices, and by replacing the use of fertilisers with manure or slurry (negative values in the plot).

The results of the models can only be as good as the data used to generate them. The first stage of development has relied on data publicly available on various repositories managed by different UK organisations (DEFRA, CLA, CEH). The second stage requires the support of the farming community in order to improve the accuracy of the current models, and determine its usefulness through its application on real cases.

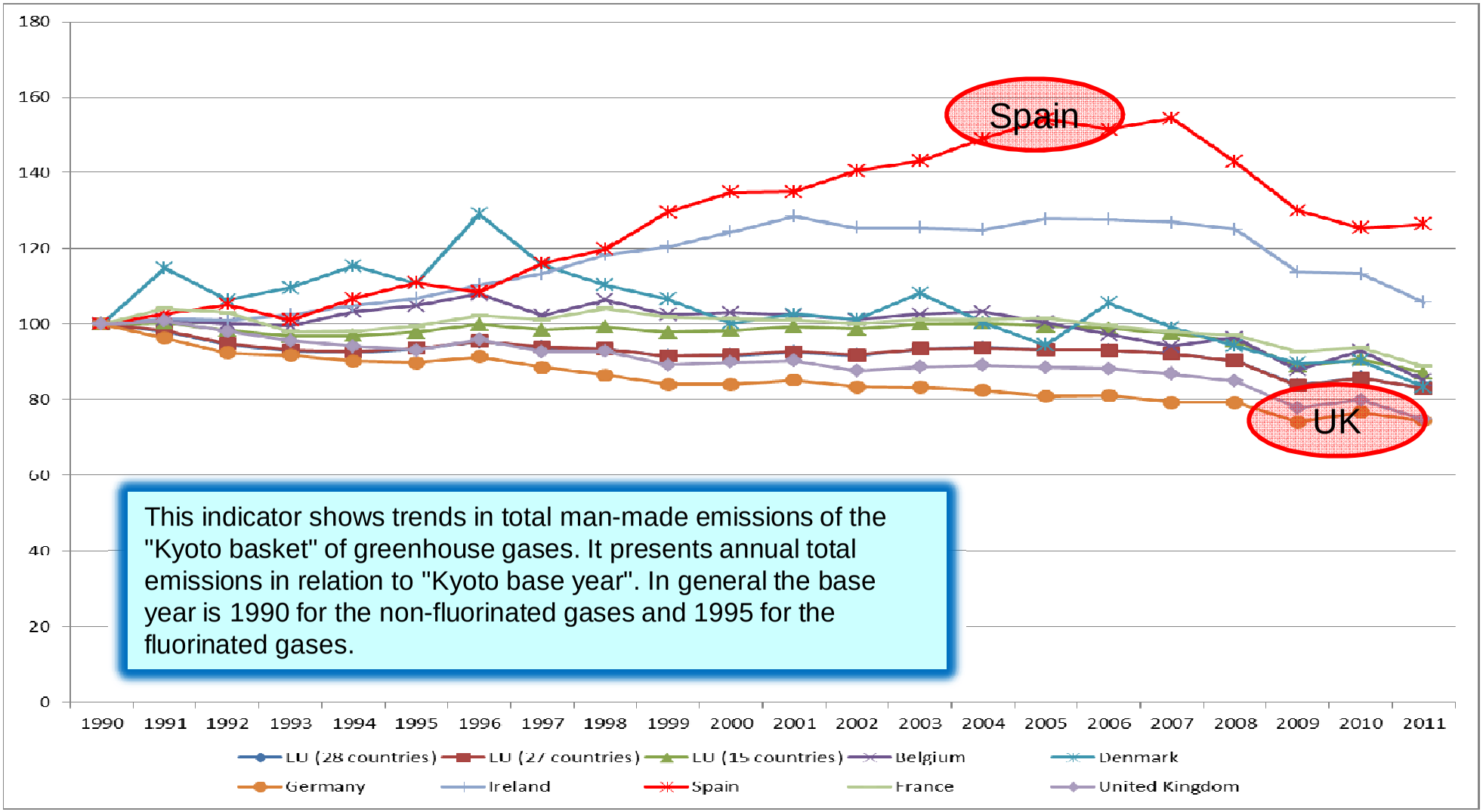
In exchange for your data, we offer practical advice service for farmers through:

- A tool to help you gain a better understanding of the positive/negative impact of your environmental efforts on the farm's business.
- Scenarios to help you decide which mitigation method will be more cost effective.
- The opportunity to optimise your business with regards to GHG emissions, taking into account the farm's emission sources, and sequestering potential linked to: land use and management, energy consumption, livestock.

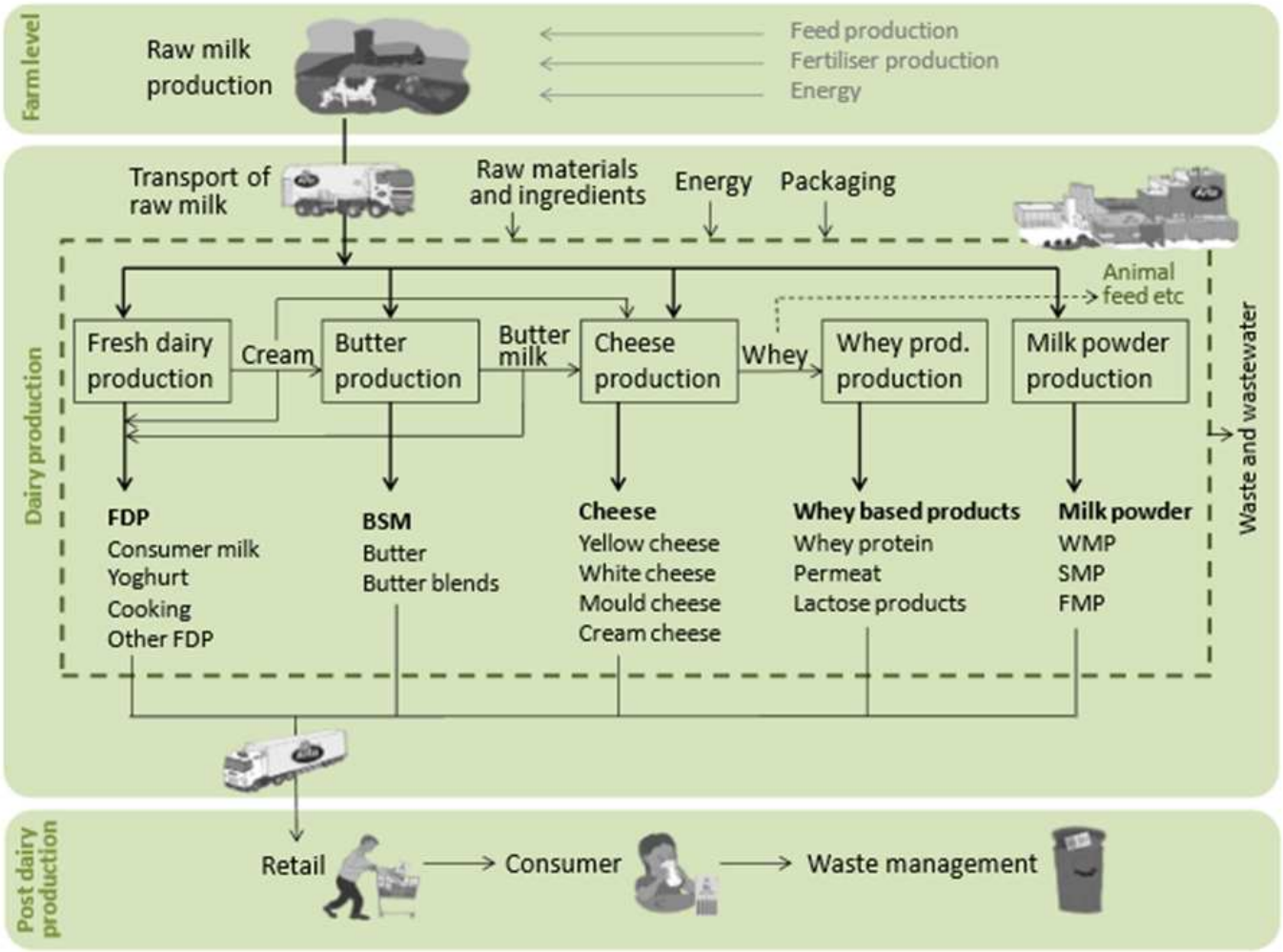
For further information contact

Dr Elena Pérez-Miñana
University of Surrey, Guildford, GU2 7XH
Phone 01256 783575 Mobile 07909773912
Email elena.perezminana@blinternet.com
(Wed - Frid, 10 til 4)

GHG emissions EU 2013



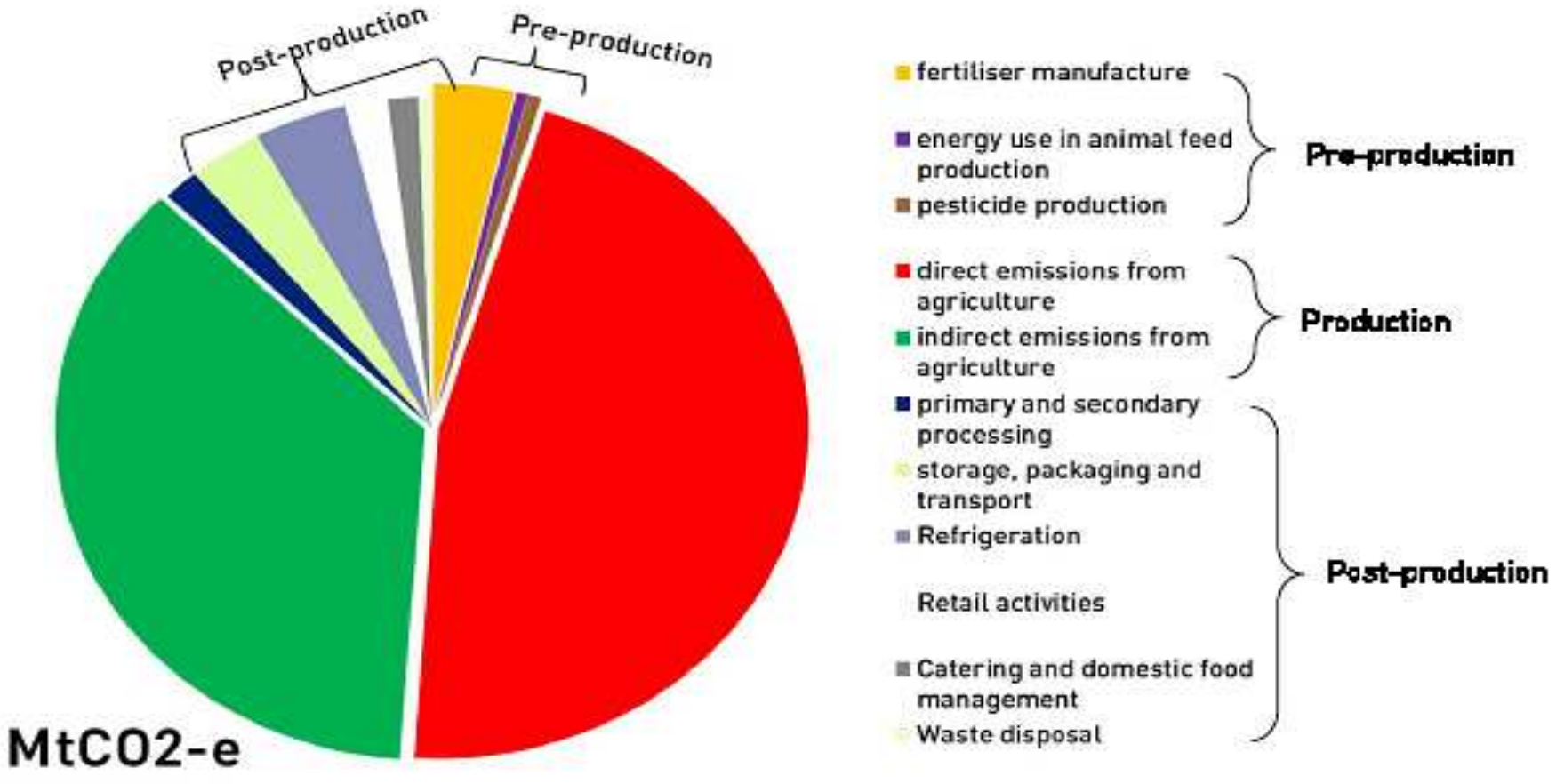
How can we reduce GHG emissions from food production?



- Human diet changes (consumption)
- Reducing losses in the food chain
  - (production, retailers, consumption)

Source: anna flysjö, PhD thesis 2012

How does FOOD PRODUCTION contribute to GHG emissions?



$MtCO_2$-e=12,095 ± 2898

Vermeulen *et al.* (2012)

Nitrogen loss in food waste at consumption

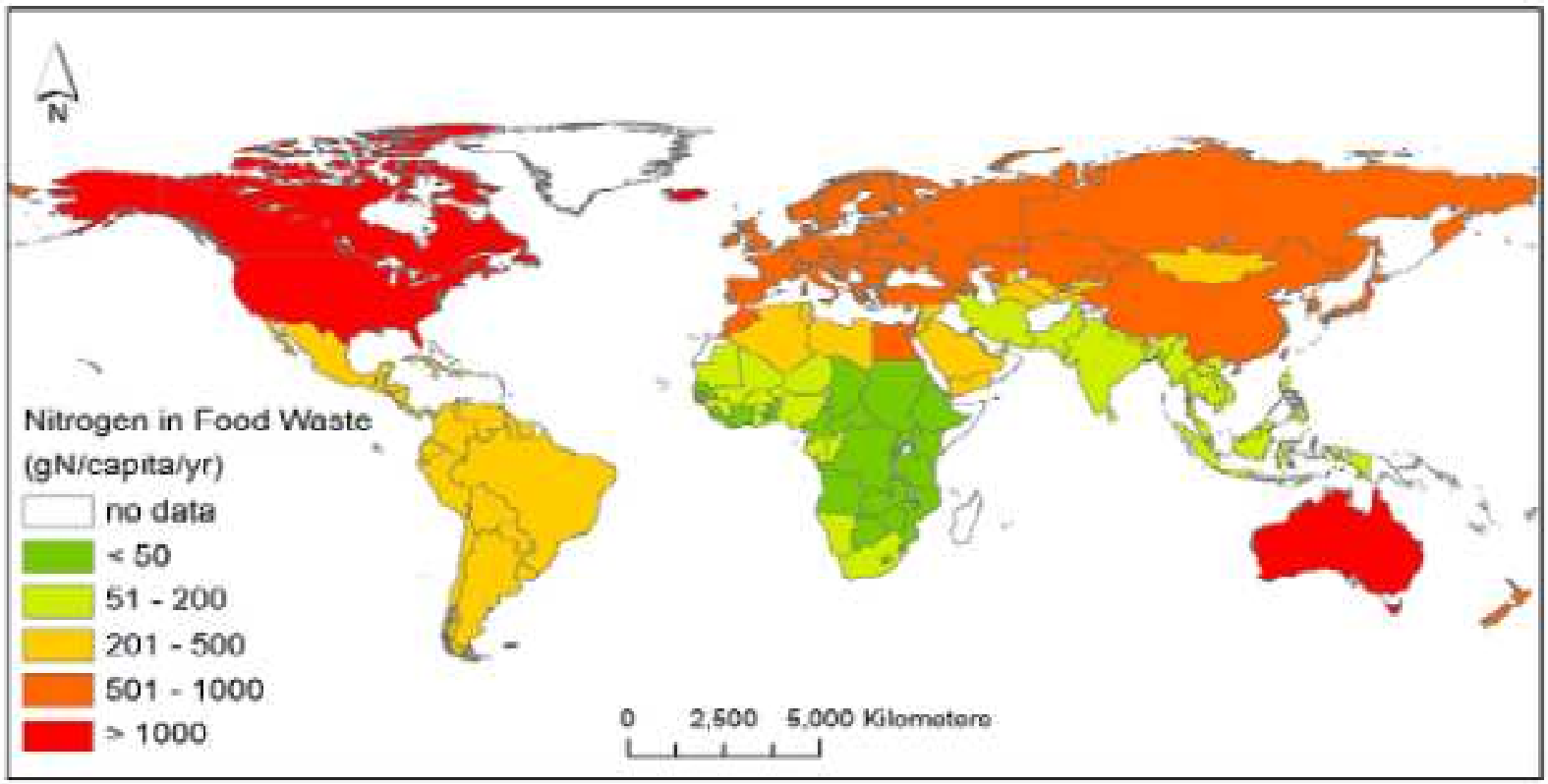


Fig. 1 – Nitrogen loss in food waste at consumption (gN per capita per country, 2007).

source: Grizzetti et al. (2013)

My Path

- Born: Madrid (Spain)
- School (Baccalaureate): Mérida (Venezuela)

- University (CSE): Caracas (Venezuela)
- University (MSc, PhD): Edinburgh (Scotland)

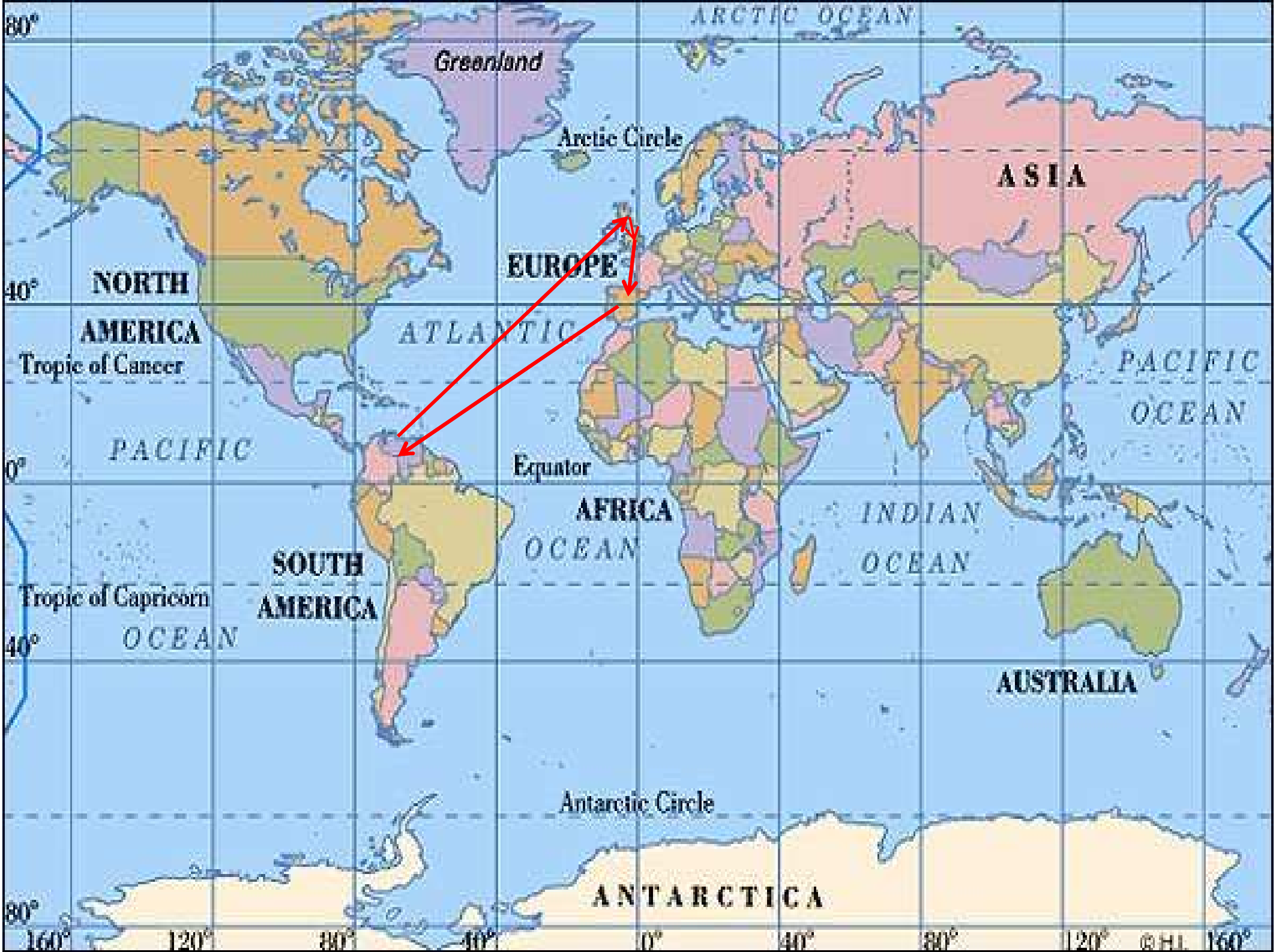
10 Years

- R&D: Redhill, Basingstoke (England)
- Research: Wales
- Research: Guildford (England)

15 Years

- Research: Bilbao (BC3)

Since July 2012


80°
ARCTIC OCEAN
Greenland
Arctic Circle
ASIA
EUROPE
40°
NORTH
AMERICA
ATLANTIC
Tropic of Cancer
PACIFIC
OCEAN
PACIFIC
0°
Equator
AFRICA
INDIAN
OCEAN
OCEAN
SOUTH
AMERICA
Tropic of Capricorn
OCEAN
40°
AUSTRALIA
Antarctic Circle
ANTARCTICA
80°
160°
120°
80°
40°
0°
40°
80°
120°
160°
©H.L.

bc3

BASQUE CENTRE
FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

ARIES

ARtificial Intelligence for Ecosystem Services

What do I research?

EUSKO JAURLARITZA
GOBIERNO VASCO
INGURUMEN ETA LURRALDE ANTOLAMENTU SAILA
DEPARTAMENTO DE MEDIO AMBIENTE Y ORDENACIÓN DEL TERRITORIO

EUSKO JAURLARITZA
GOBIERNO VASCO
HEZKUNTZA, UNIBERTSITATE ETA IKERKETA SAILA
DEPARTAMENTO DE EDUCACIÓN, UNIVERSIDADES E INVESTIGACIÓN

Universidad del País Vasco
Euskal Herriko Unibertsitatea

ikerbasque
Basque Foundation for Science

ihobe

Bilbao Days

- **B**asque **C**entre for **C**limate **C**hange (BC3)
- **A**ttaining **S**ustainable **S**ervices from **E**cosystems through **T**rade off **S**cenarios (**ASSETS**)

Photo by Erwin Palacios CI Colombia

© The Economist

The Team

- (BC3) Basque Centre for Climate Change
- University of Southampton
- University of Dundee
- Conservation International, USA and Colombia
- CIAT: International Centre for Tropical Agriculture (Cali, Colombia) plus Colombian research centres, universities and NGOs
- Chancellor College, Malawi and LEAD Africa
- Worldfish, Malawi
- Rhodes University

Brings together expertise in

- Social sciences
- Food security and nutrition
- Economics
- Ecology
- Environmental modeling
- Risk management
- Spatial planning
- Climate change

BASQUE CENTRE
FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

ARIES

ARtificial Intelligence for Ecosystem Services

What are Ecosystem Services?
Why does it matter?

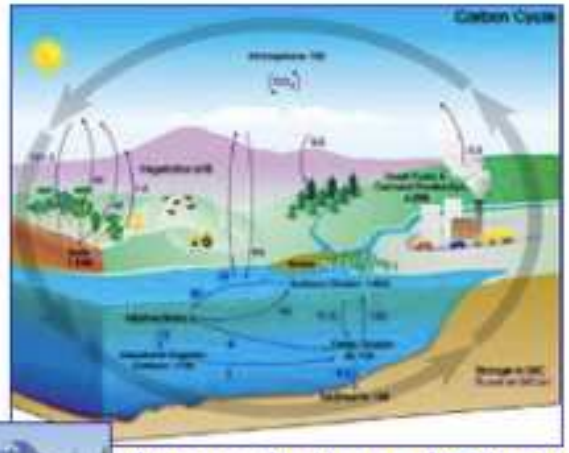
EUSKO JAURLARITZA
GOBIERNO VASCO
INGURUMEN ETA LURRALDE ANTOLAMENTU SAILA
DEPARTAMENTO DE MEDIO AMBIENTE Y ORDENACIÓN DEL TERRITORIO

EUSKO JAURLARITZA
GOBIERNO VASCO
HEZKUNTZA, UNIBERTSITATE ETA IKERKETA SAILA
DEPARTAMENTO DE EDUCACIÓN, UNIVERSIDADES E INVESTIGACIÓN

Universidad del País Vasco
Euskal Herriko Unibertsitatea

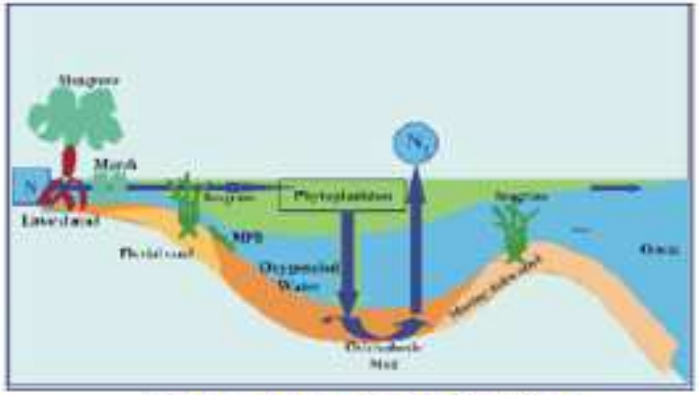
ikerbasque
Basque Foundation for Science

ihobe



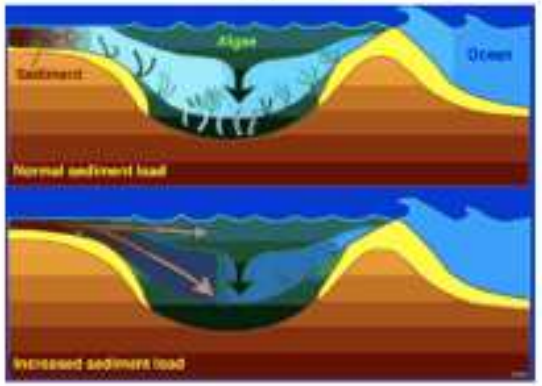
Atmospheric and Climate Regulation

Flood Attenuation/ Storm Surge Protection



Biogeochemical Cycling

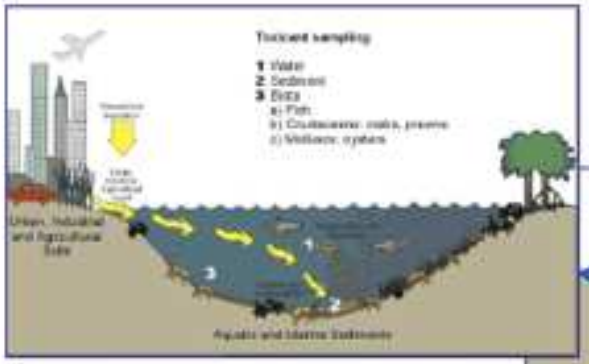
Recreation / Aesthetic



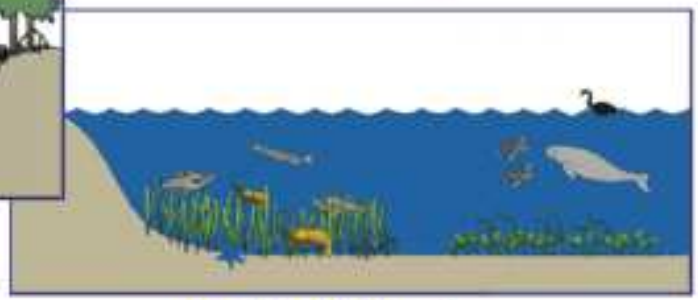
Soil and Sediment Regulation

Food and Fiber

Water Quality and Supply



Waste Regulation



Habitat/Fisheries

Pest and Disease Regulation

Ecosystem Services

The overarching goal is to explicitly quantify the linkages between the natural ecosystem services that affect – and are affected by – food security and nutritional health for the rural poor at the forest-agricultural interface

Photo by Erwin Palacios CI Colombia

Sub-Saharan Africa: Malawi

- One of the poorest countries on earth:
  - 52% in poverty, 29% undernourished
- Mostly deforested:
  - 27% remaining
- Prolonged droughts and occasional extreme rain
- Regions of interest: *Zomba*
  - 80% of people are subsistence farmers or smallholders;
  - Differences in rainfall, water availability, forest cover…
  - ….but with some protected forests and wetlands (under pressure from overexploitation & drought)

Data from UNDP, FAO, CIA Factbook; image from nyastimes

Amazonia: Colombia

- Extremes of wealth and poverty in a fast growing economy
- 45% forested - mostly in Amazonia and Andes, but under great pressure
- Suffering climate & weather extremes: La Niña, Climate Change
- Region of interest: *Caquetá*
  - 62% living in poverty
  - At different stages of transition - driven by incoming settlers, clearance for cattle, soya, biofuels
  - Several protected forest areas
  - Indigenous groups may be most threatened by land use changes

Data from UNDP, FAO, CIA Factbook; image from telegraph.co.uk

A complex ecosystem where agro-ecosystem meets “natural” ecosystems

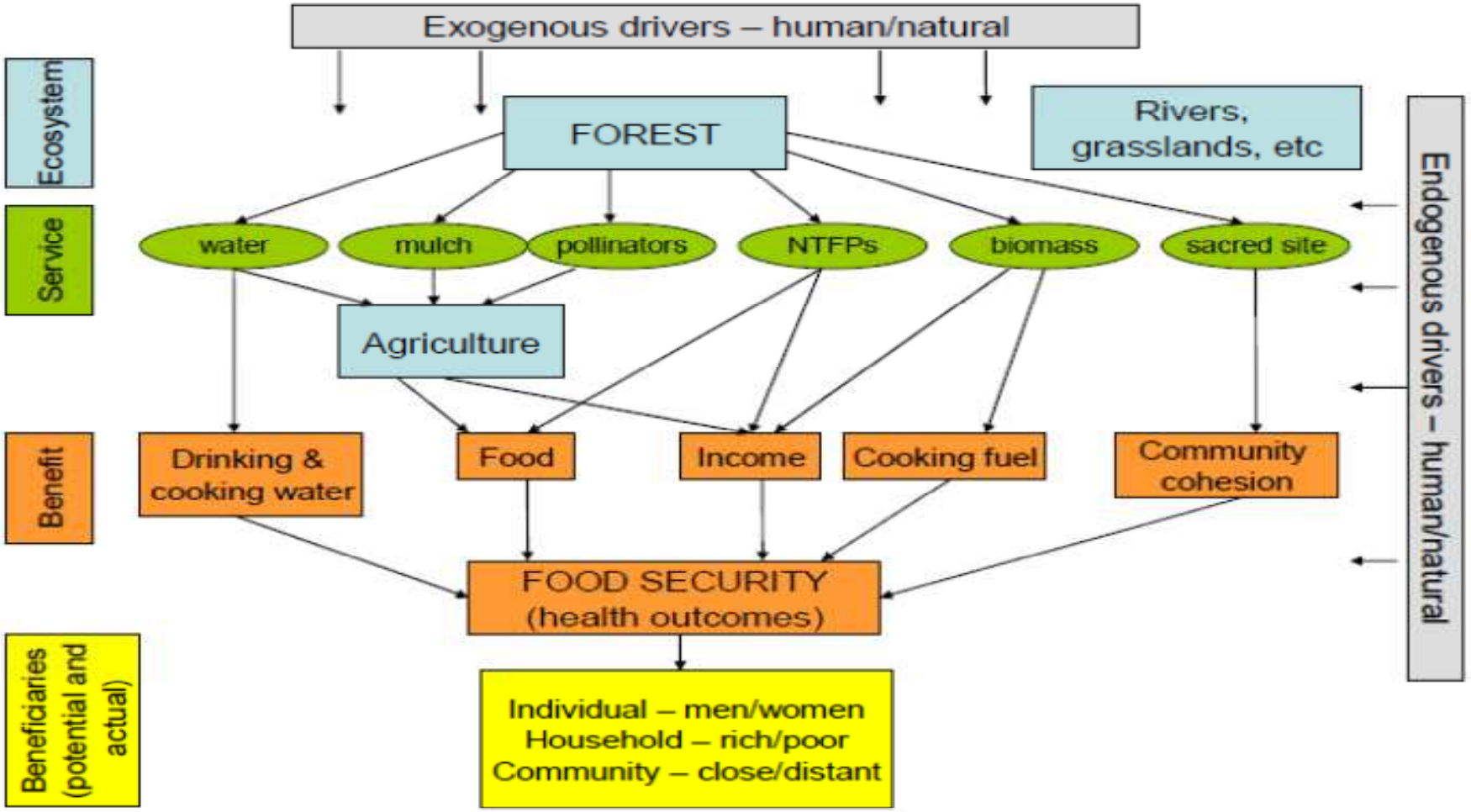


Fig. 1 *Example of the complex interactions of multiple ecosystem services from forests and their direct and indirect contribution to food security for different beneficiary groups. Note that most arrows could be multi-directional as feedbacks exist between all levels.*

BASQUE CENTRE
FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

ARIES

ARtificial Intelligence for Ecosystem Services

What is Science?

EUSKO JAURLARITZA
GOBIERNO VASCO
INGURUMEN ETA LURRALDE ANTOLAMENTU SAILA
DEPARTAMENTO DE MEDIO AMBIENTE Y ORDENACIÓN DEL TERRITORIO

EUSKO JAURLARITZA
GOBIERNO VASCO
HEZKUNTZA, UNIBERTSITATE ETA IKERKETA SAILA
DEPARTAMENTO DE EDUCACIÓN, UNIVERSIDADES E INVESTIGACIÓN

Universidad del País Vasco
Euskal Herriko Unibertsitatea

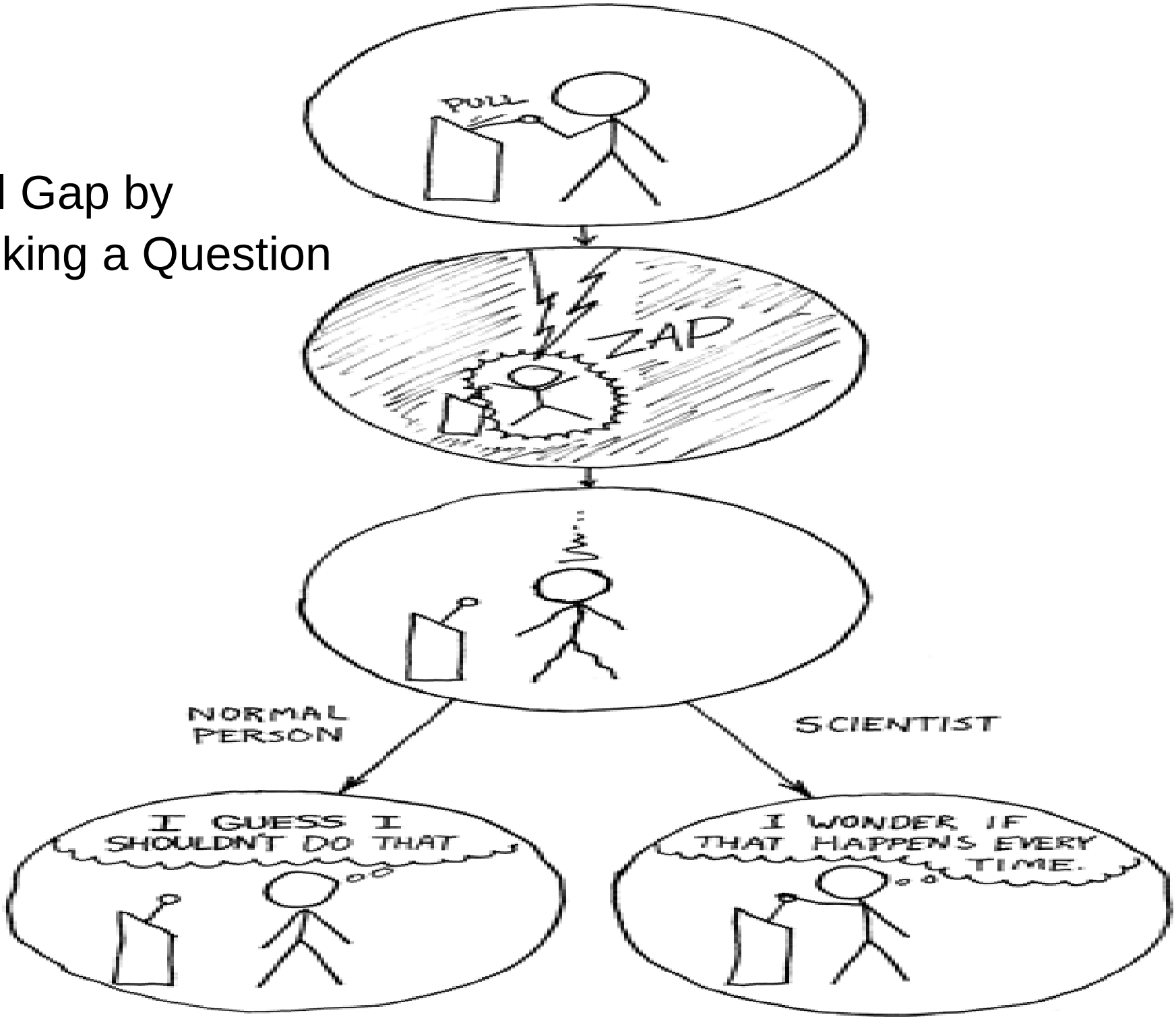
ikerbasque
Basque Foundation for Science

ihobe

What is Science?

- Knowledge of Our World (Physical, Animal, Human, ...)
- Gaps in our Knowledge
  - Know what we don´t know
  - Don´t know what we don´t know
- Science: Developing New Knowledge (Filling Gaps)
- Open-Minded System of Knowledge
  - New Information: Change Our Mind
  - Evolving and Adapting Knowledge

- Fill Gap by Asking a Question



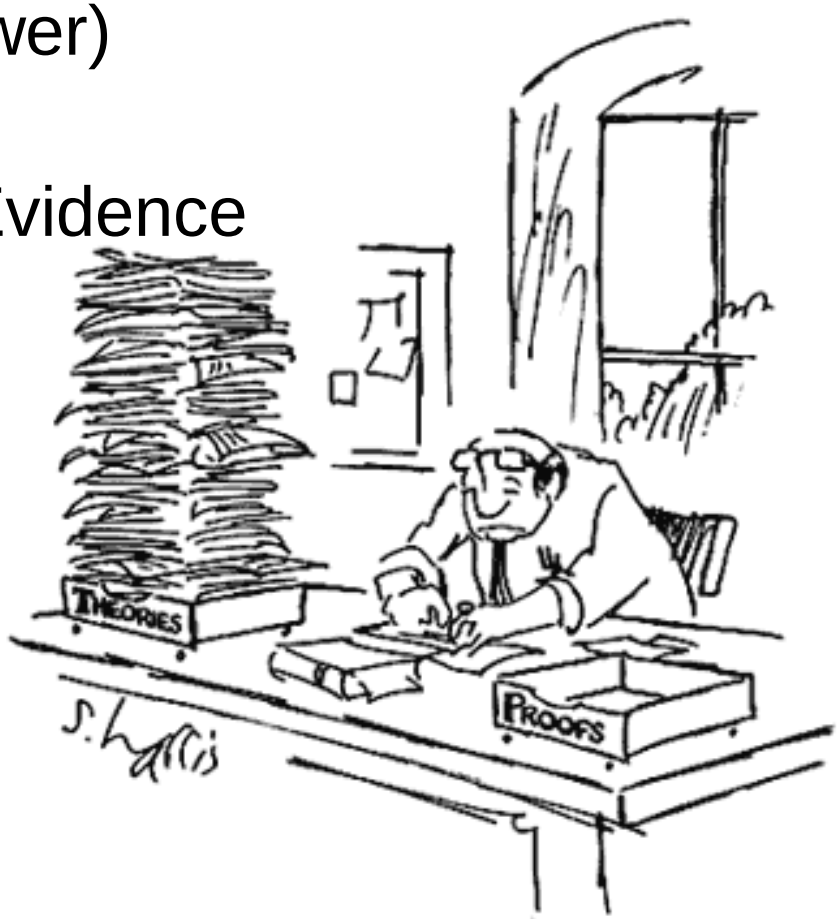
Scientist/Researcher: Being like a Detective

- Ask a Question

- Read-Up (Have people tried to answer?)
- Develop a Hypothesis & Theory
  (Answer and Reason for Answer)

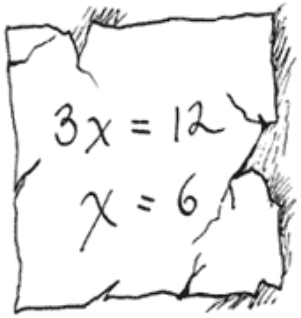
- Follow Leads, Find Clues & Build Evidence
- Analyse Evidence & Proof

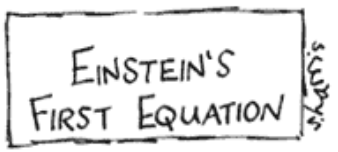
- Get Answer and Test Theory



Learning to become a Scientist/Researcher

- Learn the Basics Knowledge (Natural or Social Sciences)
  - Read/Listen
  - Always Ask Questions
- Specialise in Your Favourite Subject (University)
- Learn how to do Basic Research (University)
- Start to do Your Own Research (PhD)
- Add to the World's Knowledge Pool (Researcher)





BASQUE CENTRE
FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

ARIES

ARtificial Intelligence for Ecosystem Services

Hopefully,

Your questions addressed???

EUSKO JAURLARITZA
GOBIERNO VASCO
INGURUMEN ETA LURRALDE ANTOLAMENTU SAILA
DEPARTAMENTO DE MEDIO AMBIENTE Y ORDENACIÓN DEL TERRITORIO

EUSKO JAURLARITZA
GOBIERNO VASCO
HEZKUNTZA, UNIBERTSITATE ETA IKERKETA SAILA
DEPARTAMENTO DE EDUCACIÓN, UNIVERSIDADES E INVESTIGACIÓN

Universidad del País Vasco
Euskal Herriko Unibertsitatea

ikerbasque
Basque Foundation for Science

ihobe

Questions

- Why did you decide to go to The U.K. instead of staying here?
- Have you noticed any difference in wildlife (flora/fauna)? What?
- Have any measures been taken in agriculture in order to reduce GHG?
- How do you measure GHG?
- How will the current increase of GHG change: Any data?
  - the surface of the deserts
  - the sea level
  - glaciers surface
  - Human-beings life?
- Does The U.K. fulfill laws about GHG? Any significant law?
- Is there any chance of decreasing the amount of atmospheric GHG? How?
- Have you noticed if the increase of CO2 has increase the crops production?
- Have you noticed any differences between The UK and Spain about ecological consciousness among:
  - people?
  - government?
  - laws?
- Do you use renewable energy sources in agriculture?
- What do you do with biomass?
- What do you think about transgenic?
- Do you think CC is reversible? What can we do about it?
- Is there any difference in the amount of GHG between GHG agriculture and the traditional one?
- Water supply in The UK: sources, pollution, current situation

Have you noticed any difference in wildlife (flora/fauna)? Which?

- The climate indicator used to assess the impact of CC is temperature (others precipitation, solar radiation)
- In Spain a lot of research has been completed (and currently underway) to assess the impact to the country's flora and fauna)
- Ecosystems particularly sensitive are: the mountainous regions
- Impact on the economic sector: agriculture, commercial fishing, tourism, aquaculture and forestry

- Human beings are responsible for 77% of the emissions mostly from: burning fossil fuels (for energy generation and transport) and from deforestation

Have you noticed any difference in wildlife (flora/fauna)? Which?

- There is scientific evidence showing the impact of CC on the ecosystems, particularly the organisms' phenology, the distribution of the species and the composition and dynamics of the communities
- In Europe the evidence are the extreme weather events, mainly:
  - droughts, high precipitation, heat waves, forest fires
- Between 1975 and 2001, 238 floods were recorded in Europe, of particular im`portance 2002
- In Spain desertification shows a worrying trend
- Spain is the most barren country in Europe (31.5% shows evidence)
- 6% of the soil has degraded in an irreversible manner
- Temperature increase and precipitation patterns will worsen the situation

http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database#

SOURCE OF INFORMATION

- [tsdnr420] - Fishing fleet, total engine power – kilowatts The EU fishing effort is measured here as the total engine power of the fishing fleet. The data are for the registered fishing vessels of EU Member States, Iceland and Norway. In general the data refer to the situation of the national fleets on 31 December of the reference year. The EU-data are derived from the Community Fishing Fleet Register managed by the Directorate-General for Fisheries and Maritime Affairs. Data for Iceland and Norway are supplied directly by the national authorities.

- [tsdnr210] - Sufficiency of sites designated under the EU Habitats directive - %: index of sufficiency of Member States proposals for sites designated under the habitats directive measures the extent to which Sites of Community Importance proposed by the Member States adequately cover the species and habitats listed in Annexes I and II to the habitats directive. 100% indicates sufficiency of proposals for all Annex I terrestrial habitat types and Annex II terrestrial species of Community interest occuring in Member States' territories.

BASQUE CENTRE
FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

ARIES

ARtificial Intelligence for Ecosystem Services

So,

Can you do Science???

EUSKO JAURLARITZA
GOBIERNO VASCO
INGURUMEN ETA LURRALDE ANTOLAMENTU SAILA
DEPARTAMENTO DE MEDIO AMBIENTE Y ORDENACIÓN DEL TERRITORIO

EUSKO JAURLARITZA
GOBIERNO VASCO
HEZKUNTZA, UNIBERTSITATE ETA IKERKETA SAILA
DEPARTAMENTO DE EDUCACIÓN, UNIVERSIDADES E INVESTIGACIÓN

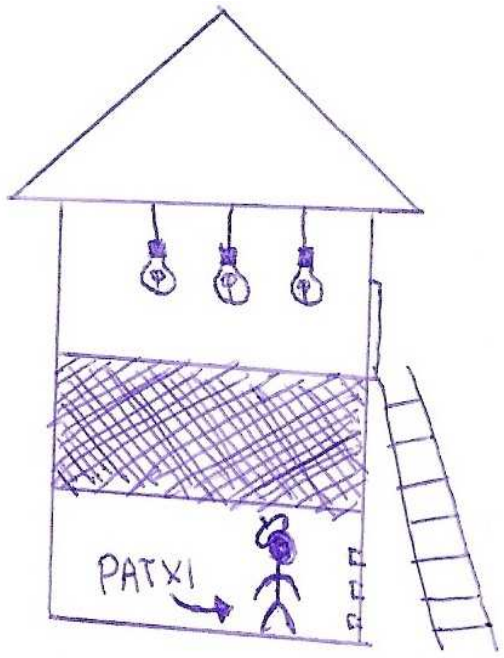
Universidad del País Vasco
Euskal Herriko Unibertsitatea

ikerbasque
Basque Foundation for Science

ihobe

- Think, think, think…**PUZZLE: 3 light switches, 3 bulbs**

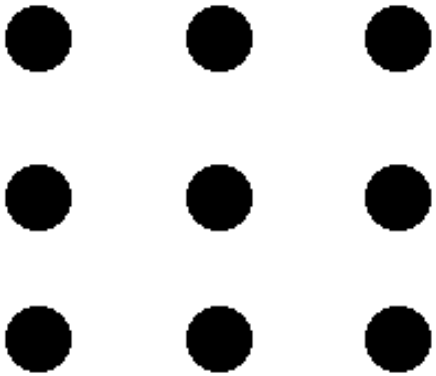
"Patxi is in a room on the ground floor which has 3 light switches. These switches control 3 light bulbs in the room above. He can visit the room where the bulbs are located only once. He must figure out which switch turns on which bulb. How can he figure this out?"

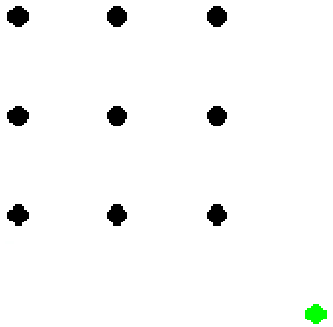


- Solution: Turn on Switches 1 and 2 and wait, then turn off switch 1 and climb to the top floor. The light that's on would be switch 2, the warm bulb would be connected to switch 1 and the cold bulb would be connected to switch 3

- Think, think, think…**PUZZLE: nine dots**

"There are nine dots evenly distributed in three rows. Your challenge is to draw four straight lines which should go through the middle of all the dots without taking the pencil off the paper. If you are using a pencil, you may start from any position and draw the lines one after the other without taking your pencil off the page. Each line starts where the last line finishes"





BASQUE CENTRE
FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

ARIES

ARtificial Intelligence for Ecosystem Services

Why become a Scientist/Researcher?

EUSKO JAURLARITZA
GOBIERNO VASCO
INGURUMEN ETA LURRALDE ANTOLAMENTU SAILA
DEPARTAMENTO DE MEDIO AMBIENTE Y ORDENACIÓN DEL TERRITORIO

EUSKO JAURLARITZA
GOBIERNO VASCO
HEZKUNTZA, UNIBERTSITATE ETA IKERKETA SAILA
DEPARTAMENTO DE EDUCACIÓN, UNIVERSIDADES E INVESTIGACIÓN

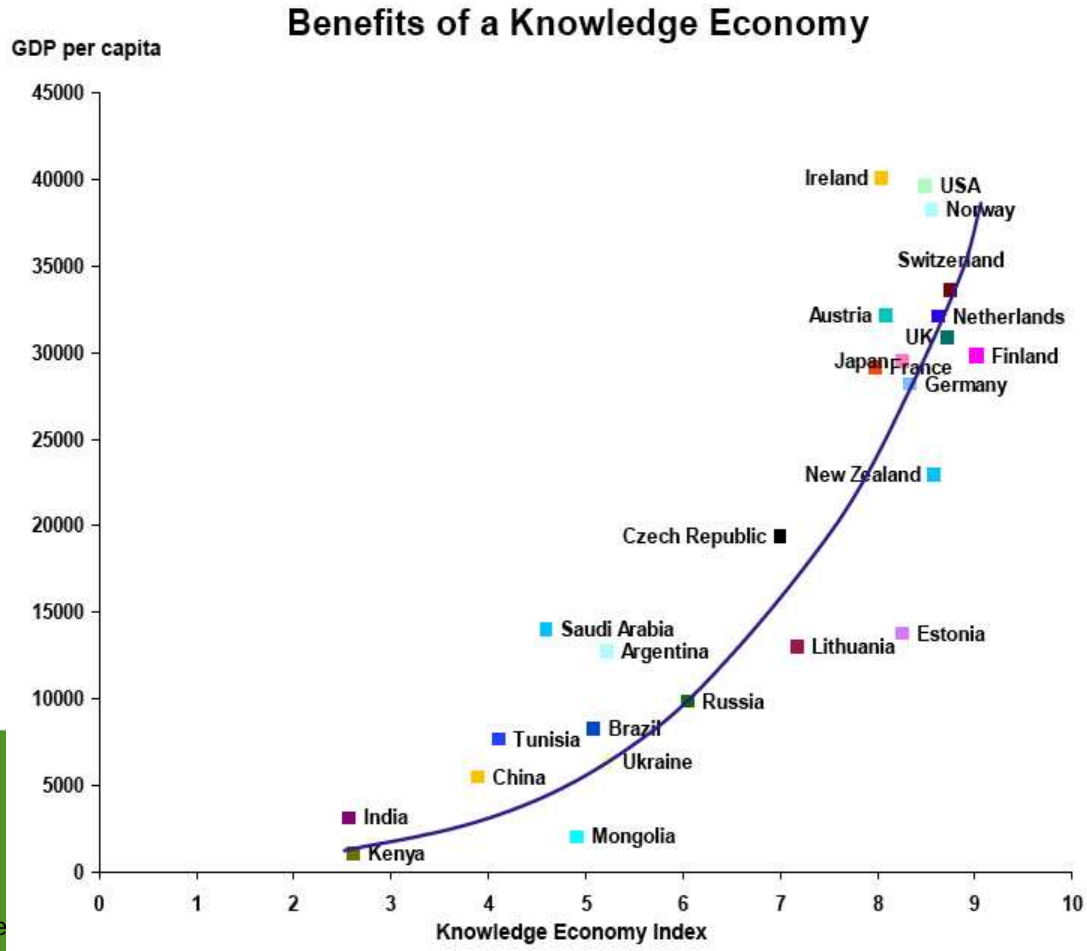
Universidad del País Vasco
Euskal Herriko Unibertsitatea

ikerbasque
Basque Foundation for Science

ihobe

Be Part of the Knowledge Economy

- Knowledge Economy:
  - New Knowledge will Improve our Well-Being
  - Countries investing Science, Technology are Wealthier
- Basque & EU Government
  - Investing in Science
- Science can be:
  - Job Opportunities
  - Exciting Work



BASQUE CENTRE FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

profe

Scientist/Researcher: Curiosity, Creativity & Good Grades

- Be Curious, Observant & Interested in the World

- Looking at the World Differently/Unexpected Angle
- Creative: Put together Unrelated Ideas
- Ask Questions
- Find a Way to Look at the World and Think about the World

- Good Grades at School
- Patience, Persevere


Thanks for your attention!
Eskerrik Asko!!

BASQUE CENTRE
FOR CLIMATE CHANGE
Klima Aldaketa Ikergai

ARIES

ARtificial Intelligence for Ecosystem Services

BC3

http://www.bc3research.org/

The Story of Stuff

http://www.youtube.com/watch?v=gLBE5QAYXp8

Contact

elena.perezminana@bc3research.org

EUSKO JAURLARITZA GOBIERNO VASCO
INGURUMEN ETA LURRALDE ANTOLAMENTU SAILA
DEPARTAMENTO DE MEDIO AMBIENTE Y ORDENACIÓN DEL TERRITORIO

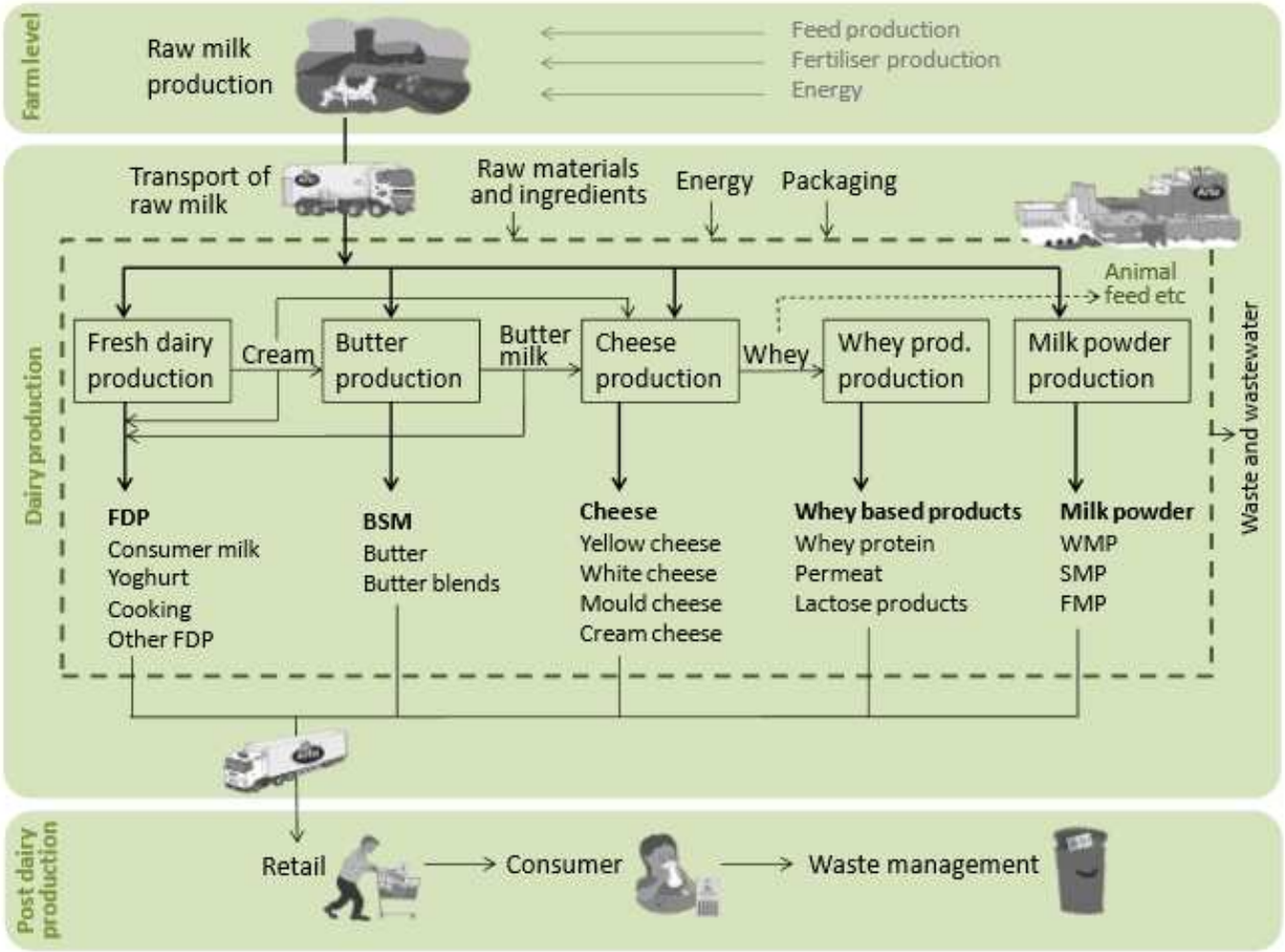
EUSKO JAURLARITZA GOBIERNO VASCO
HEZKUNTZA, UNIBERTSITATE ETA IKERKETA SAILA
DEPARTAMENTO DE EDUCACIÓN, UNIVERSIDADES E INVESTIGACIÓN

Universidad del País Vasco Euskal Herriko Unibertsitatea

ikerbasque
Basque Foundation for Science

ihobe

GHG emissions estimation for cradle to grave



Source: anna flysjö, PhD thesis 2012

Ecosystems Services

BIENES Y SERVICIOS DE LOS ECOSISTEMAS

BIENES
(Servicios de aprovisionamiento)
Alimento, fibra y combustible
Recursos genéticos
Productos bioquímicos
Agua dulce

SERVICIOS CULTURALES
Valores espirituales y religiosos
Sistema de conocimientos
Educación e inspiración
Recreación y valores estéticos

SERVICIOS REGULADORES
Resistencia a las invasiones
Reproducción vegetal
Polinización
Diseminación de las semillas
Regulación de las plagas
Protección contra riesgos naturales
Regulación de la erosión
Purificación de las aguas

SERVICIOS DE APOYO
Producción primaria
Aseguramiento del hábitat
Ciclo de los nutrientes
Formación y retención del suelo
Producción de oxígeno atmosférico
Ciclo de los recursos hídricos