

**bc<sup>3</sup>**

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**

## 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?

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**How I got here?**



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## 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)



## 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)
- Participate in Class: 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”



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## 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



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## University Days: Post-Graduate



- Studied Information Technology and Artificial Intelligence
- Start Working Harder: More Inspired/More Interested
- Questioning What I Read
- Proposing New Ideas
- Publishing Papers in Journals

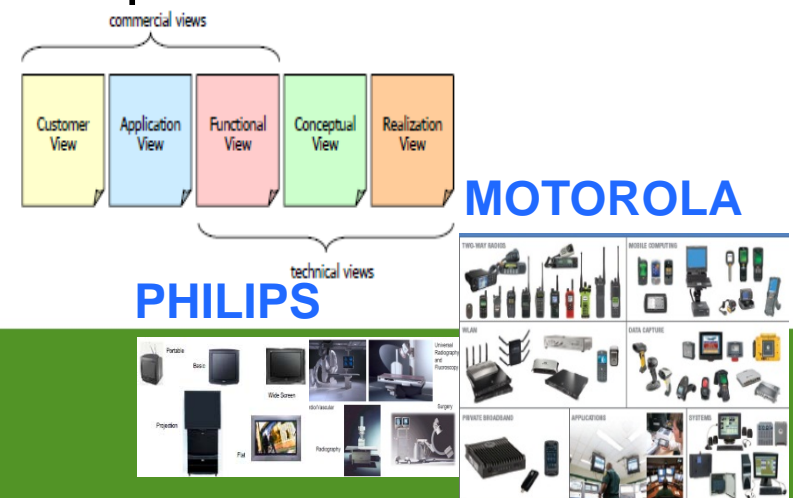
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## Research Days

- 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



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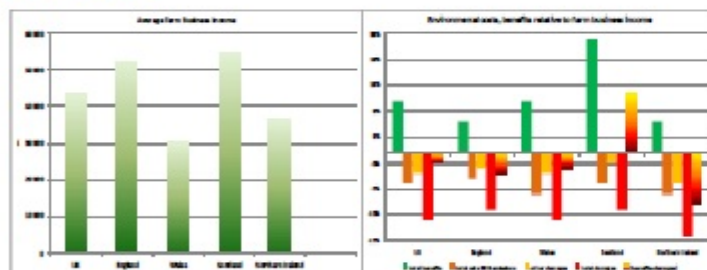
## Bayesian Networks to support Greenhouse Gas Emission reduction in the Agricultural Sector (BaNGAS)

July 2010

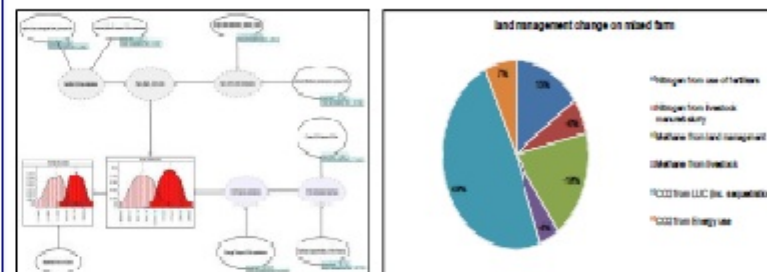
BaNGAS is a research project, launched as a KTA by the University of Surrey. It aims to support Farm Carbon's efforts to assist farmers in finding cost-effective means of achieving the reduction of GHG emissions in their farm activities. This aim will be achieved by:

- 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:

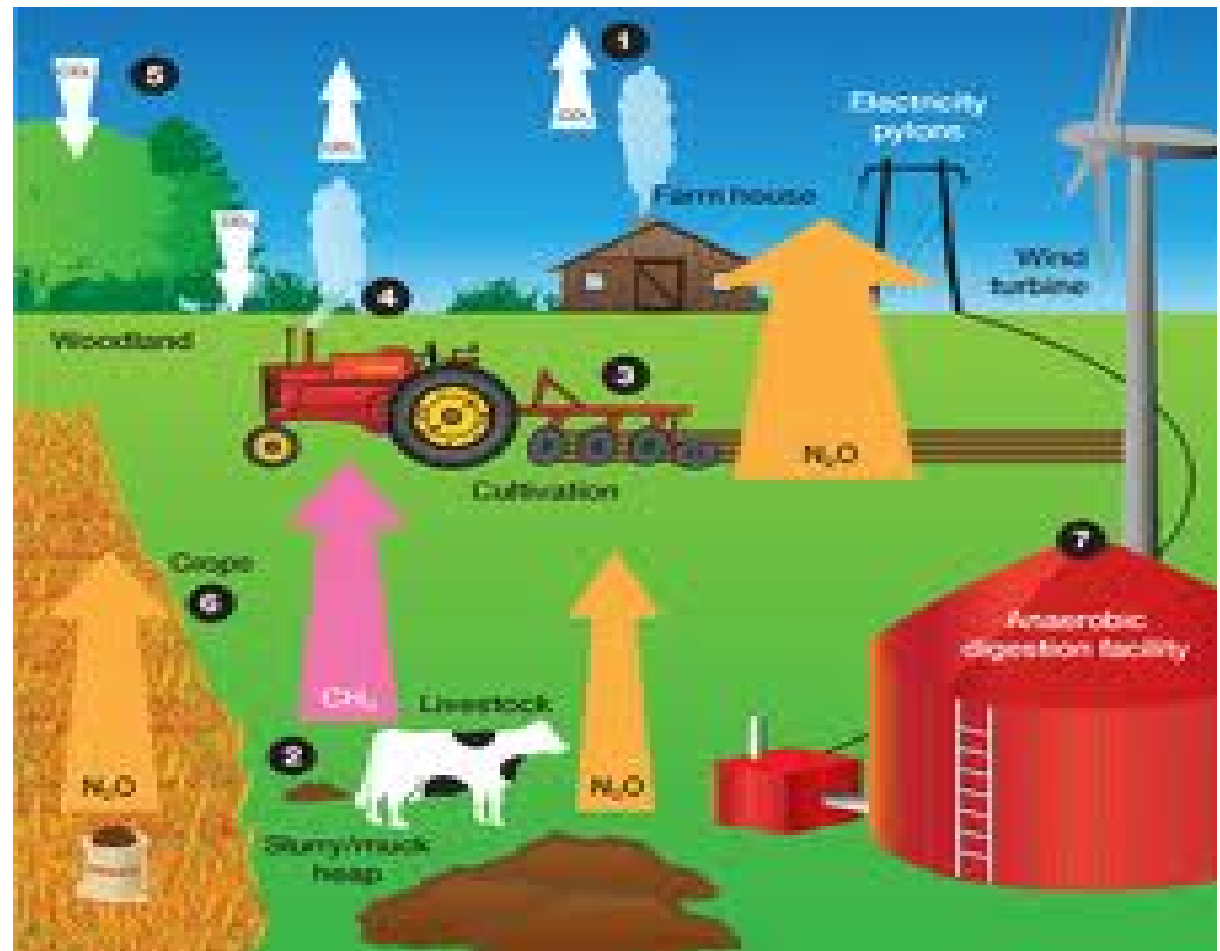
- A tool to help you gain a better understanding of the positive/negative impact of your environmental efforts on the farm's business.
- Scenarios to help you decide which mitigation method will be more cost effective.
- The opportunity to optimise your business with regards to GHG emissions, taking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

For further information contact

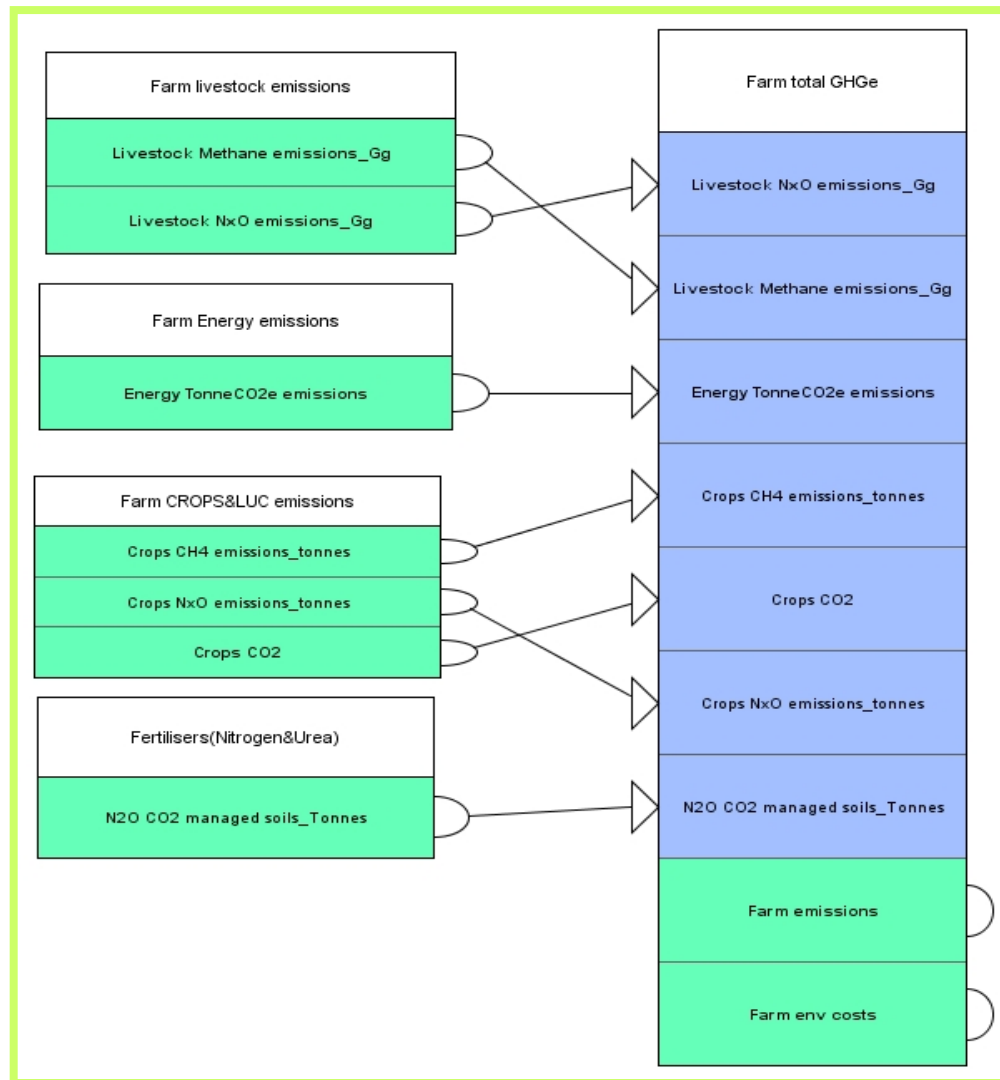
Dr Elena Pérez-Miñana  
University of Surrey, Guildford, GU2 7XH  
Phone 01256 783575 Mobile 07909773912  
Email [elena.perezminana@btinternet.com](mailto:elena.perezminana@btinternet.com)  
(Wed - Frid, 10 till 4)

## Sources of GHG emissions on a Farm

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

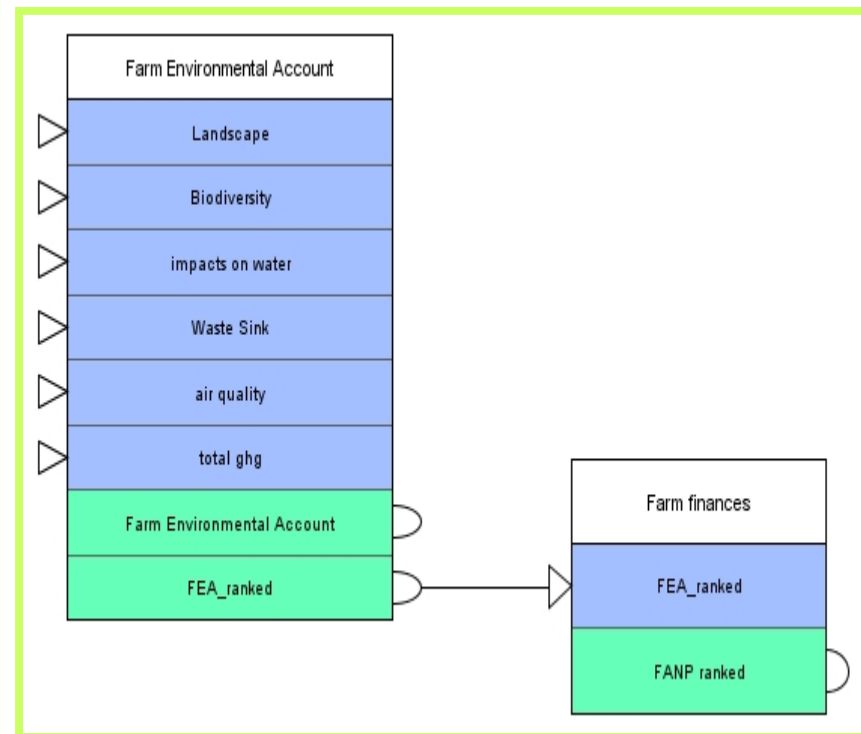


## BBN GHGe & SPC



## Top level architecture

### Farm environmental account BBN







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## Bilbao Days

- Basque Centre for Climate Change (BC3)
- Attaining Sustainable Services from Ecosystems through Trade off Scenarios (**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





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# ARIES

ARtificial Intelligence for Ecosystem Services



## What are Ecosystem Services? Why does it matter?



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Y ORDENACIÓN DEL TERRITORIO



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UNIVERSIDADES E INVESTIGACIÓN



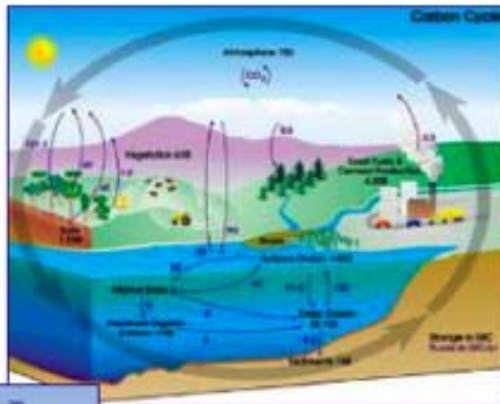
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del País Vasco

Euskal Herriko  
Unibertsitatea

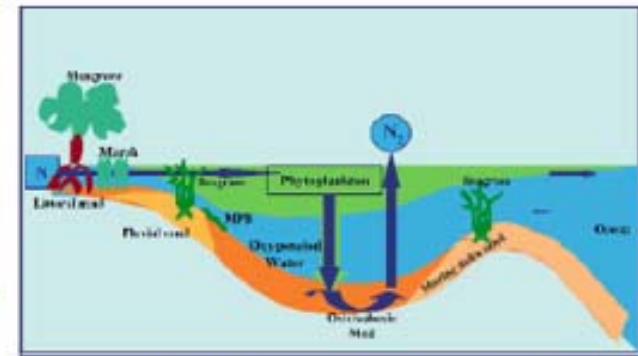
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Flood Attenuation/  
Storm Surge Protection



Biogeochemical Cycling

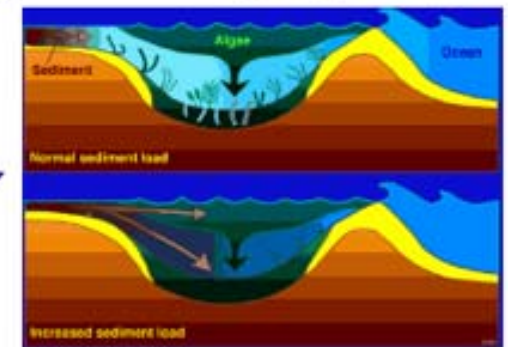


Recreation / Aesthetic

Atmospheric and Climate  
Regulation



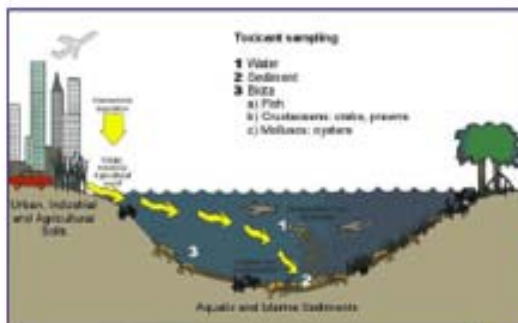
Food and Fiber



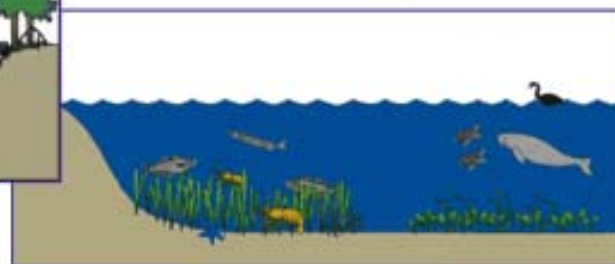
Soil and Sediment Regulation



Water Quality and Supply



Waste Regulation



Habitat/Fisheries



Pest and Disease  
Regulation

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



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Photo by Erwin Palacios CI Colombia

[www.bc3research.org](http://www.bc3research.org)



## 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)



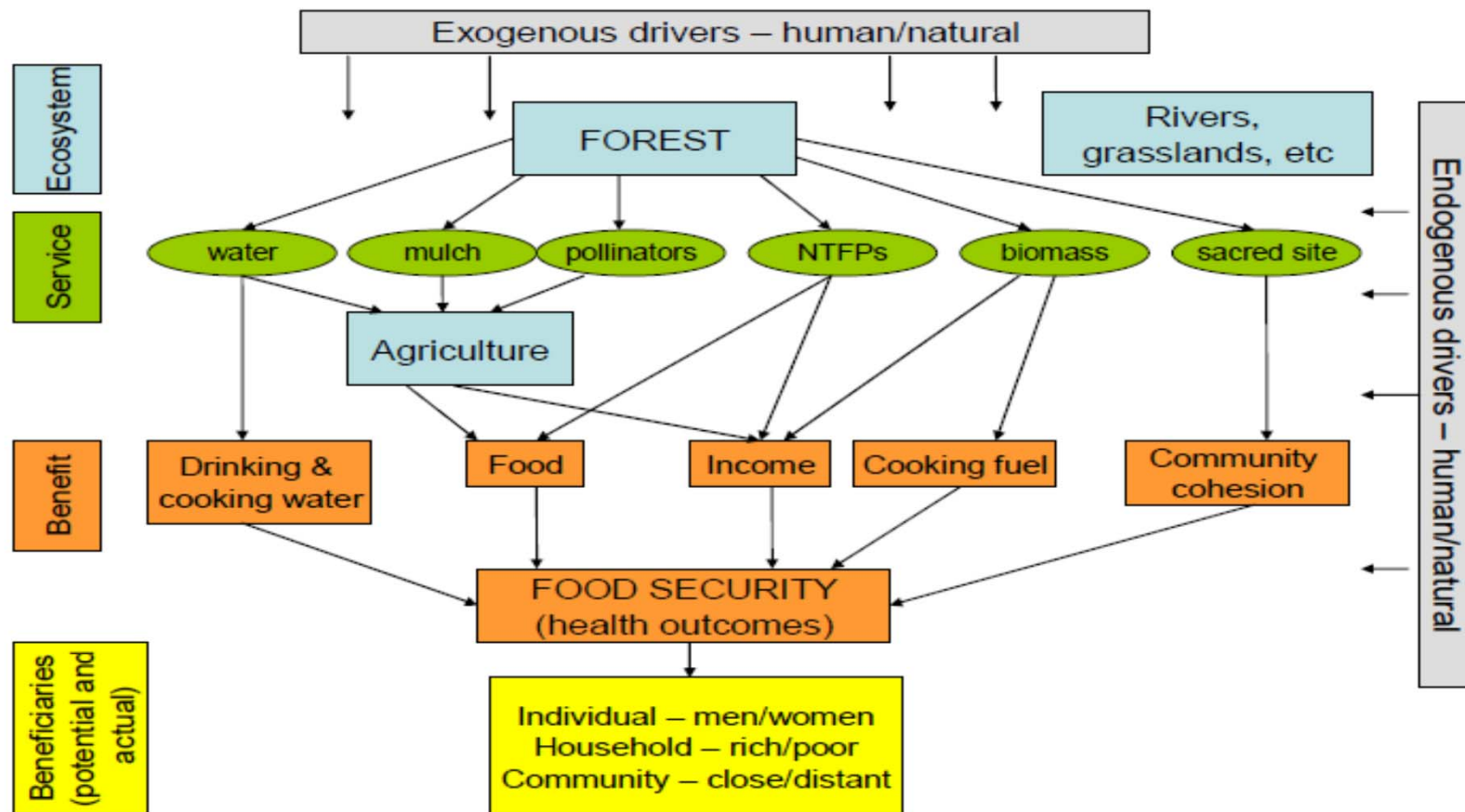


## Amazonia: Colombia

- 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



## 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.

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## What goes on at BC3?



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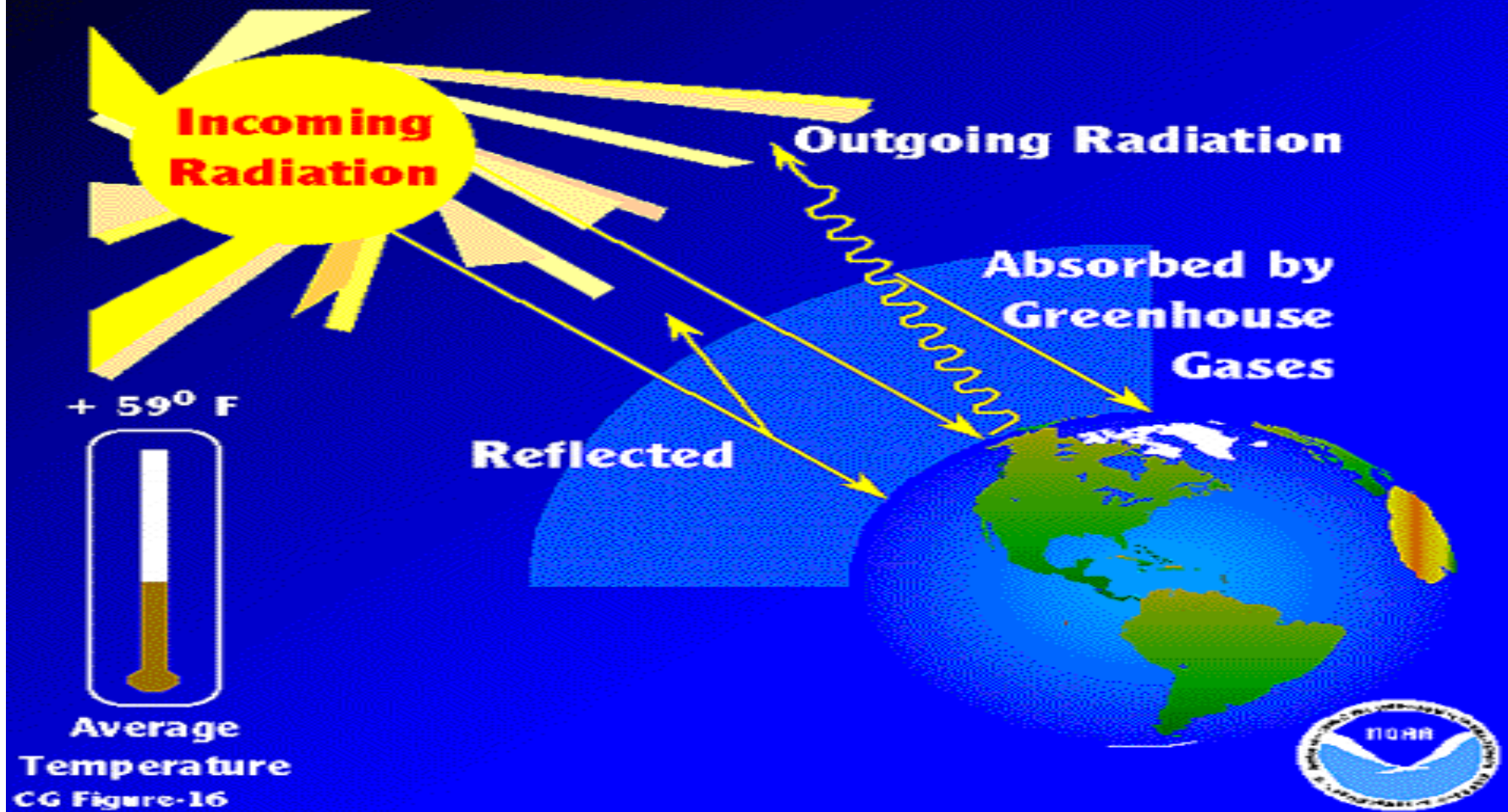
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# How the Earth's Greenhouse Effect Works



<http://www.metoffice.gov.uk/climate-change/guide/what-is-it>

## Scientists & Economists Looking at Climate Change

- Climate Change:
  - Big Physical, Natural, Economic and Social Change
- Need Scientists to Study and Understand Changes
- Economists Study Economic and Social Change
- Basque Government wants to help to Study and Understand Changes
- BC3: Mostly Economists



## Centre for Researching Climate Change

- What will Happen?
  - Change Temperatures, Weather, Coasts, Water, Food..
  - So, People Change their Behaviour:  
Air Conditioning, Shelters, Agriculture, Wars...
- How can we Adapt to Climate Change?
  - Be Ready for Changes (Physical and People)
  - Building Protection, Teach New Skills, Peace Treaties
- How can we Avoid/Reduce Climate Change?
  - Less Energy Use
  - Less Pollution (More Renewable Energy)

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**What do I research?**



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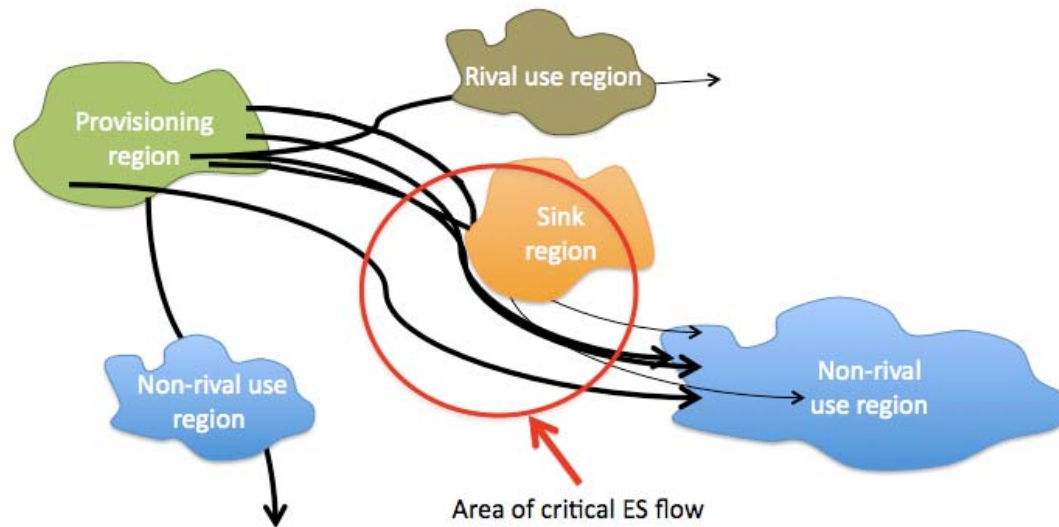


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# Developing ARIES – ARtificial Intelligence for Ecosystem Services

The screenshot displays the Eclipse IDE environment for the Thinkcap project. The main workspace is divided into several panels:

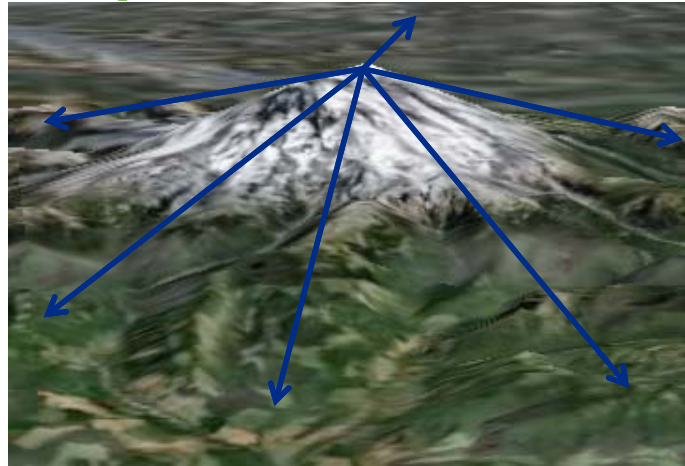
- Thinklab Navigator:** Located on the left, it shows a hierarchical tree of project files. The selected file is `vegetation-type-swgap` under the `aries.water.local.sw-north-american-deserts` package.
- Current Context:** Below the navigator, it shows a visualization of the selected file. The visualization is a colorful, abstract pattern. Below it, the text "No time context has been defined" is displayed.
- Knowledge Search:** A panel on the left side of the main workspace, currently showing "No results".
- Server Console:** A panel on the right side of the main workspace, currently empty.
- Results:** A panel on the far right, showing the results of a task. The task is "Computing vegetation-type-swgap" with a context set to "san-pedro-us250m". The results show a green checkmark and a list of notifications:
  - task1 terminated
  - creating visualization
  - total coverage is 100%
  - computing 237510 initial states



## Identifying carriers & flow paths

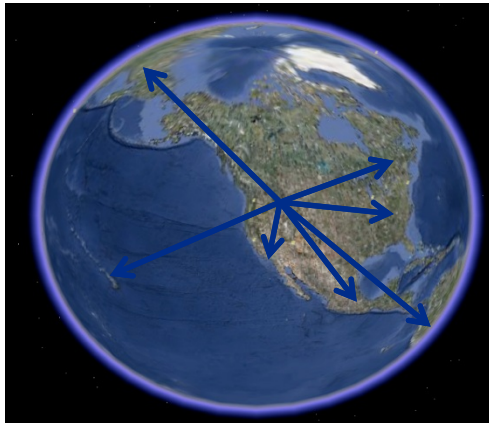


Hydrologic services



Aesthetic views

Recreation, flood regulation

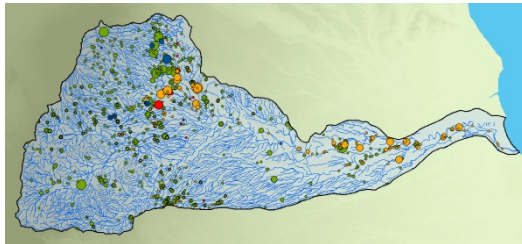


Carbon sequestration, some cultural values

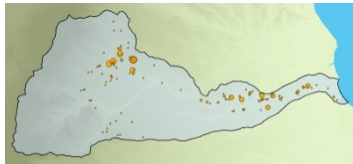
Recreation, aesthetic proximity, some cultural services



# Water Services: Veracruz , Mexico



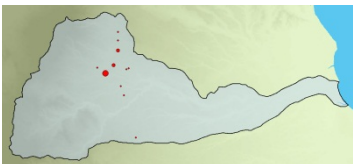
total demand from:



Agriculture



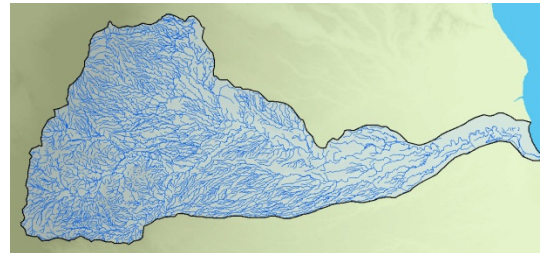
Aquaculture



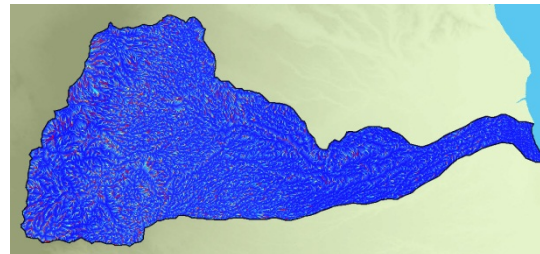
Industrial



Residential



Stream network, elevation, porosity...

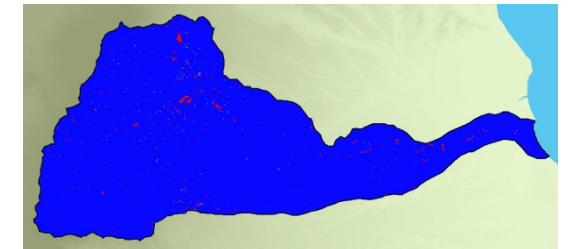


Actual flow to beneficiaries  
→ used to compute.... →

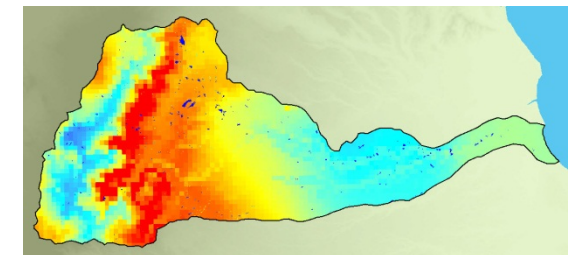
Selected results of flow modeling



Possible (usable) source



Actual surface water use



Inaccessible water source



Inguruko  
Berdegunea



IBILBIDE LUZEA  
GRAN RECORRIDO



IBILBIDE OSAGARRIA  
ITINERARIO AUXILIAR



DONEJAKUE BIDEA  
CAMINO DE SANTIAGO



AISIALDIRAKO GUNEAK  
ÁREAS DE RECREO



BASO PARKEA  
PARQUE FORESTAL



HIRIKO PARKEA  
PARQUE URBANO



BILBAO ANILLO VERDE

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## What is Science?



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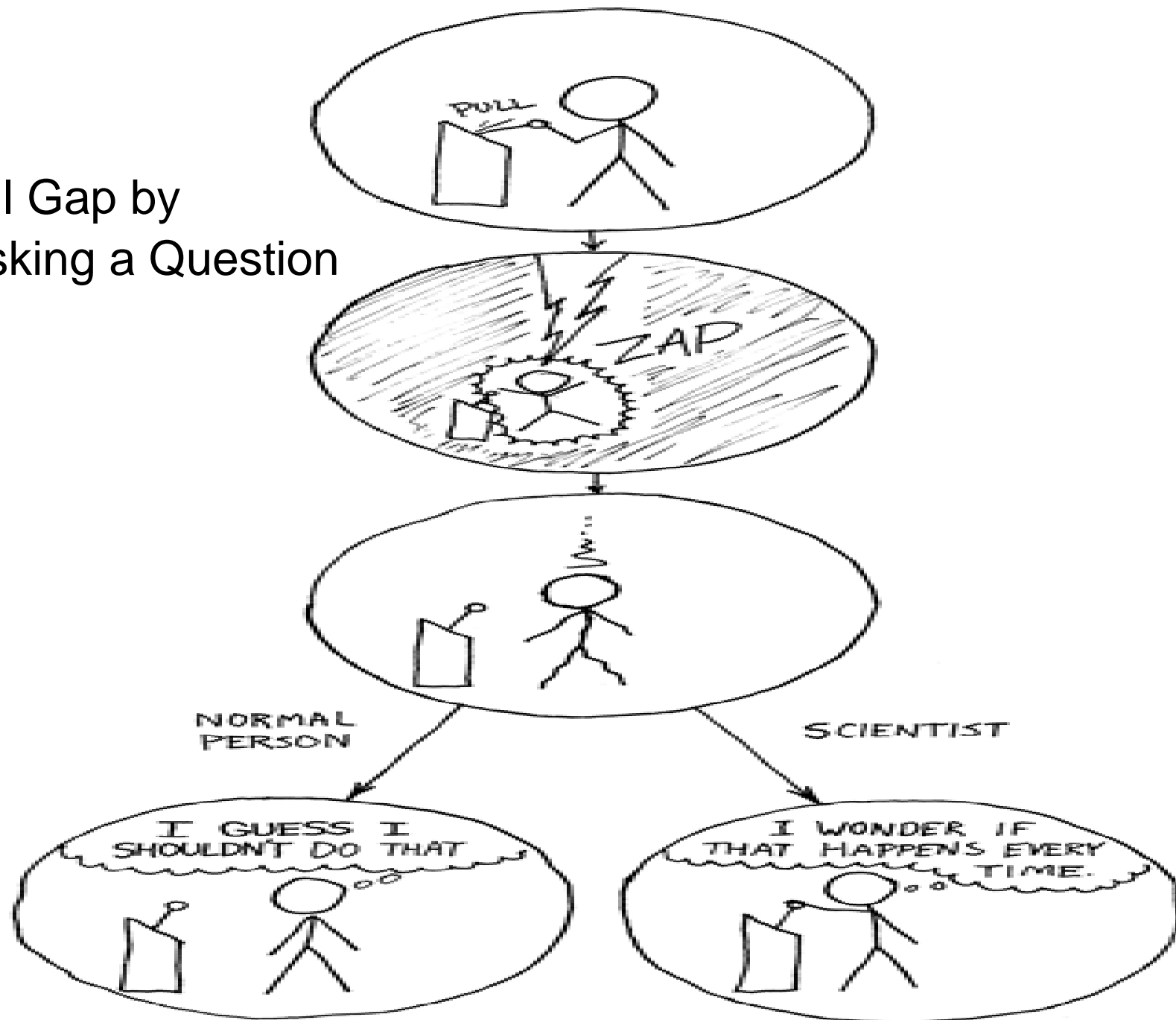


## What is Science?

- 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

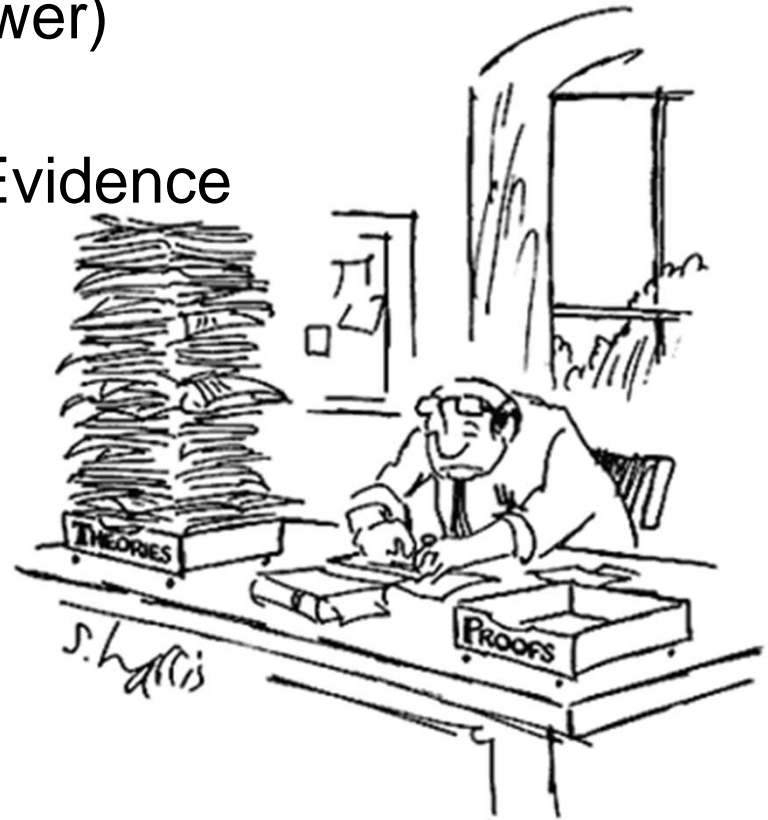


- Fill Gap by Asking a Question



## 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

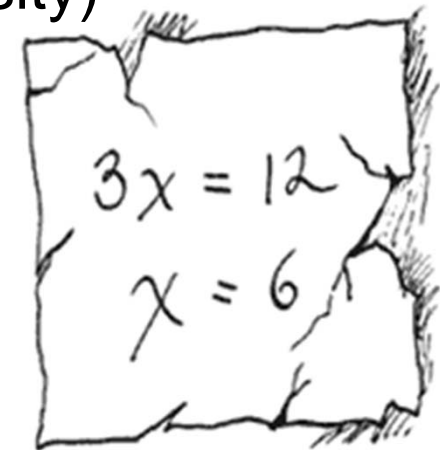
Always Ask Questions

- Specialise in Your Favourite Subject (University)

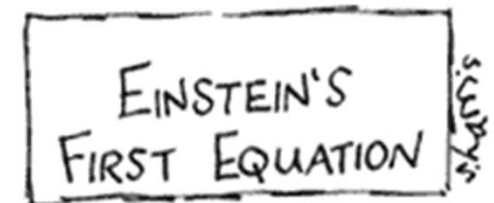
- Learn how to do Basic Research (University)

- Start to do Your Own Research (PhD)

- Add to the World's Knowledge Pool (Researcher)



A hand-drawn sketch of a piece of paper with a torn edge. It contains two mathematical equations:  $3x = 12$  and  $x = 6$ .



A hand-drawn sketch of a rectangular box. Inside the box, the text "EINSTEIN'S FIRST EQUATION" is written. To the right of the box, the word "EINSTEIN'S" is written vertically.



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So,  
Can you do Science???



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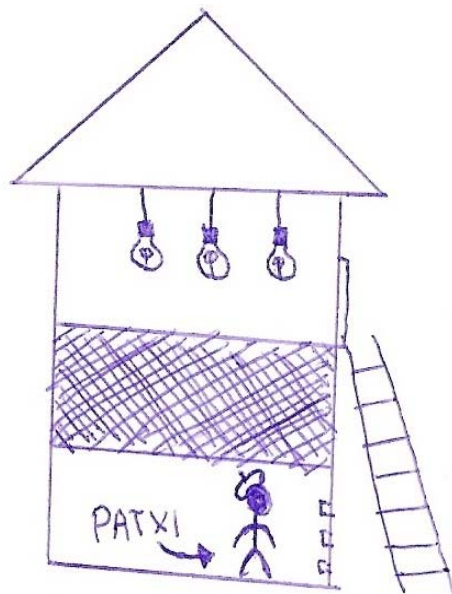
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- Think, think, think... **PUZZLE: 3 light switches, 3 bulbs**

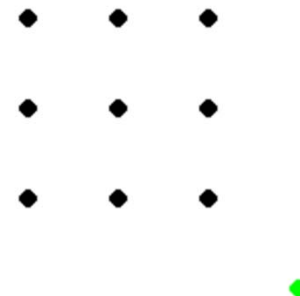
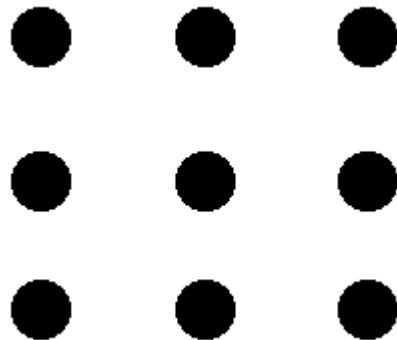
“Patxi is in a room on the ground floor which has 3 light switches. These switches control 3 light bulbs in the room above. He can visit the room where the bulbs are located only once. He must figure out which switch turns on which bulb. How can he figure this out?”



- 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”



**bc<sup>3</sup>**

BASQUE CENTRE  
FOR CLIMATE CHANGE  
Klima Aldaketa Ikergai

**ARIES**

ARtificial Intelligence for Ecosystem Services



# Why become a Scientist/Researcher?



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**ikerbasque**  
Basque Foundation for Science

**ihobe**

# Be Part of the Knowledge Economy

- Knowledge Economy:

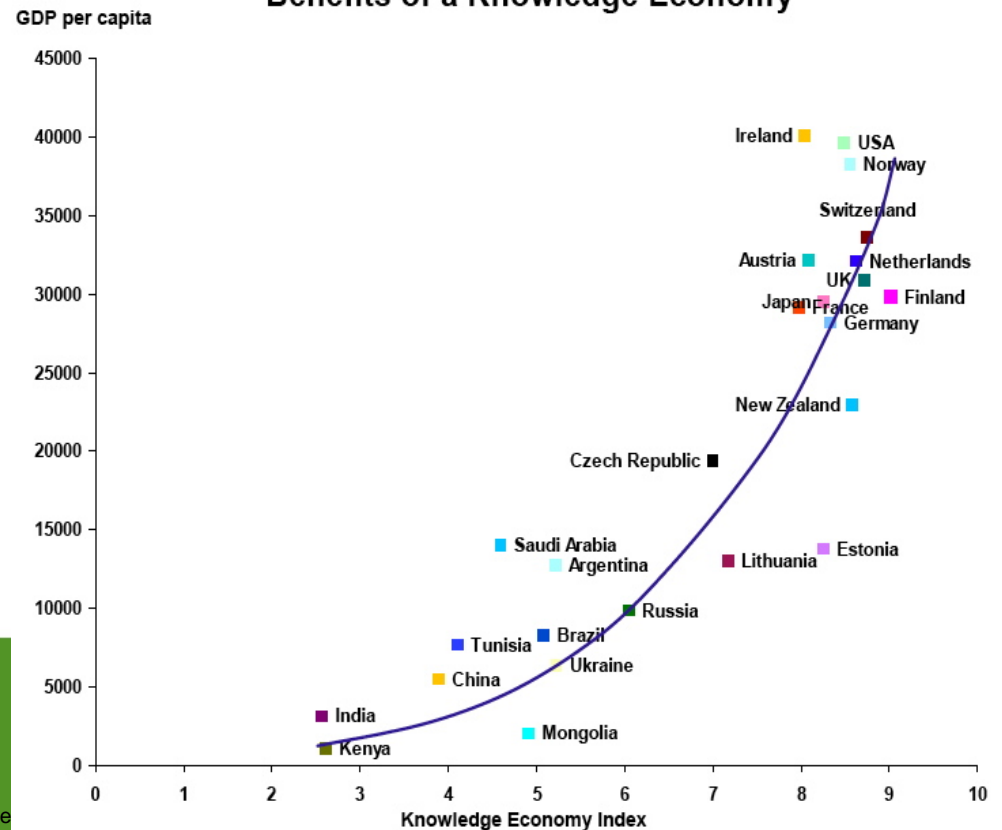
New Knowledge will Improve our Well-Being

Countries investing Science, Technology are Wealthier

- Basque & EU Government Investing in Science

- Science can be:  
Job Opportunities  
Exciting Work

Benefits of a Knowledge Economy





## 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!!***

# bc<sup>3</sup>

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# ARIES

ARtificial Intelligence for Ecosystem Services



## BC3

<http://www.bc3research.org/>

## The Story of Stuff

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

## Contact

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