

# Irish Inventory: Can we account for efficiencies and uncertainties?

Phillip O'Brien

[p.obrien@epa.ie](mailto:p.obrien@epa.ie)

*Research Specialist*

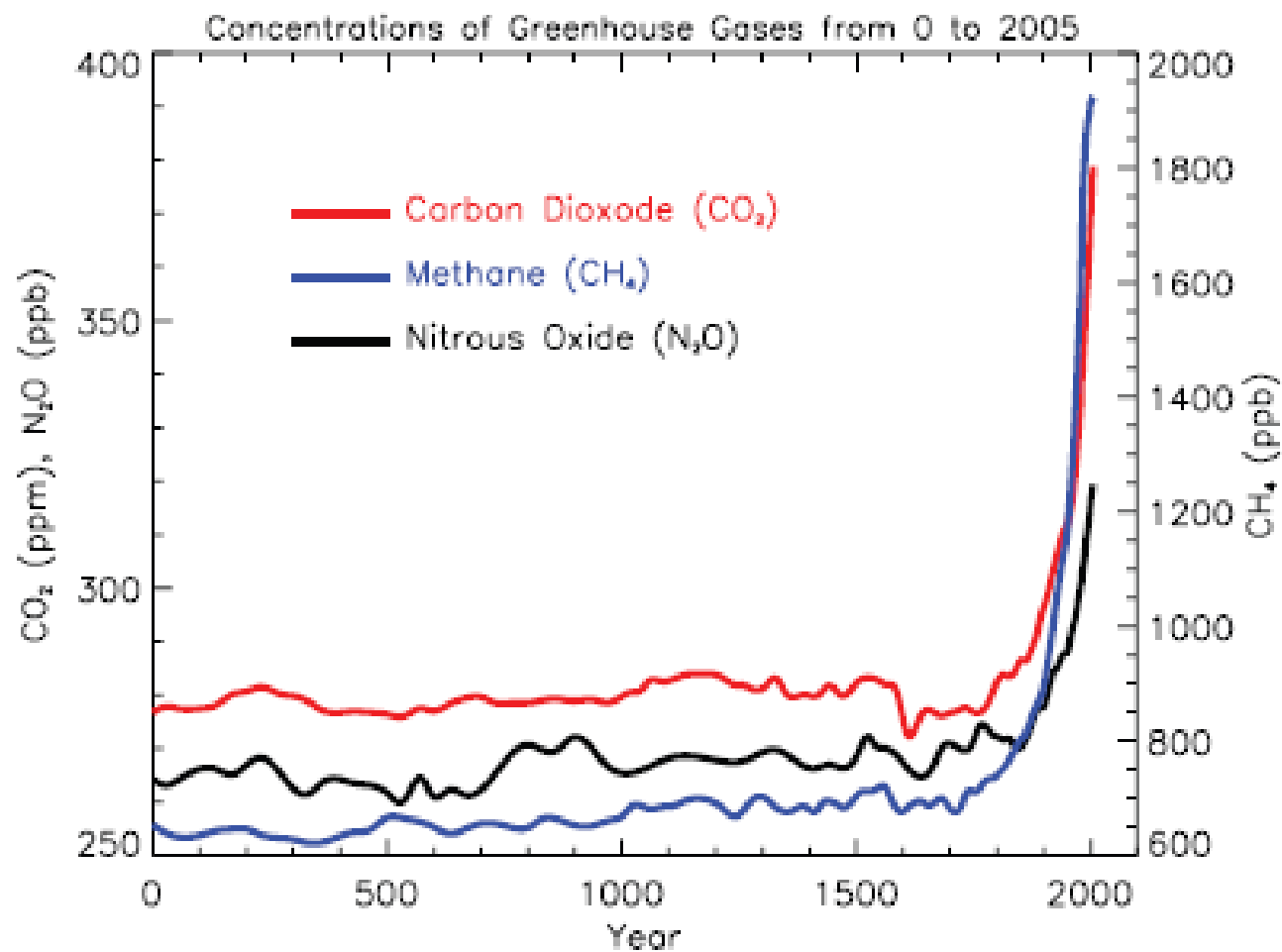
*Climate Change Research Programme*

*NUIG*

## Outline

- n Role of the EPA
- n Inventory Methodology and Timelines
- n NIR 2010 sectoral breakdown
- n Current inventory development
- n Soil Carbon in Grasslands

## Global trends in GHG



## Role of the EPA

- n EPA designated as the **Single National Entity** in Ireland with responsibility for the national inventory
- n EPA also performs the role of **Inventory Agency** (inventory compiler, QA/QC manager)
- n Data collection on the basis of **Memoranda of Understanding (MOU)** with identified **Key Data Providers**



# Inventory development

It is important that the GHG emissions reported are

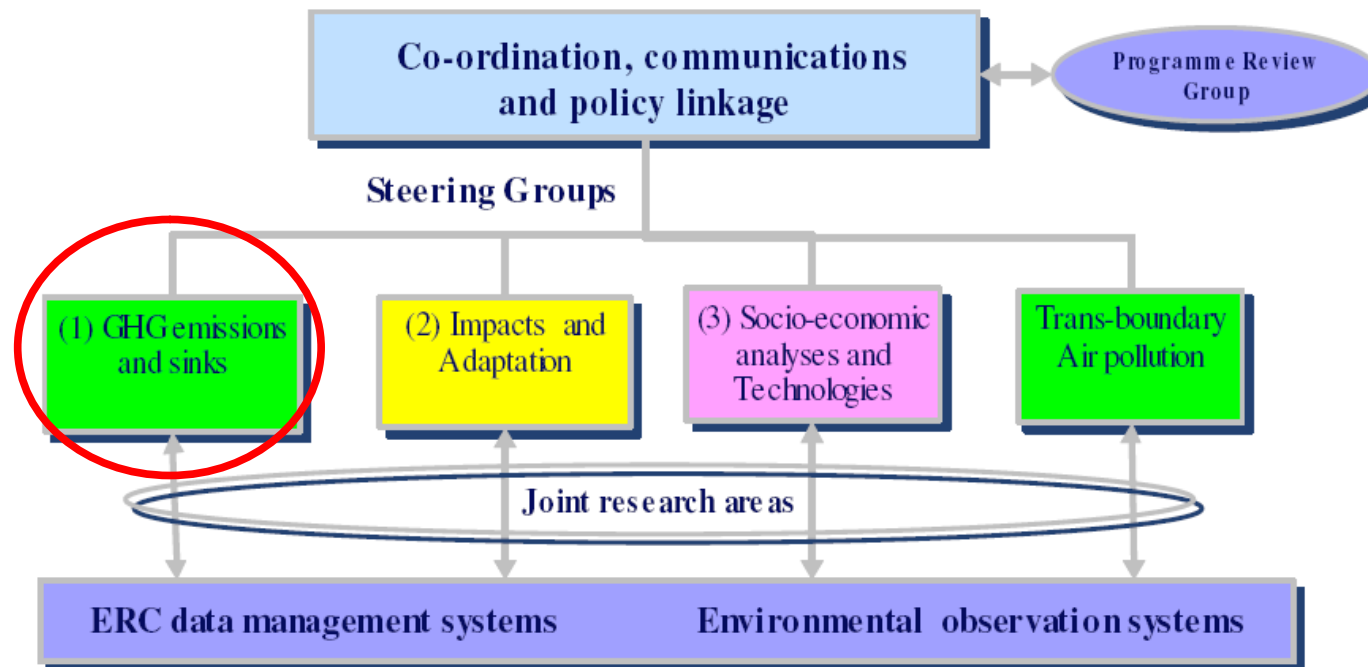
- Based on Sound Science
- Accurate
- Verifiable (open to scrutiny)
- Complete

The International Panel on Climate Change (IPCC) provides templates for making the estimates for all sectors and activities

Countries are encouraged to do improve reporting methodology for all sectors, especially Key Sector and Key Uncertainty

# Research programme

Figure 1: Climate Change Research Programme structure.



## Why produce an Inventory of GHG?

- n Part of what was agreed under UNFCCC and Kyoto
  - n Annex I countries
- n Make comparison with other countries
  - n Agreed procedures and quality control
- n Track progress towards targets
  - n Warning signs
- n Identify sectors and activities of concern
  - n Focus policy to where it will achieve best results
- n Identify gaps in knowledge
  - n science and activity data

## Why is it important?

- n The National Inventory Report of GHG emissions and associated data are the official documents from which Ireland's progress towards meeting emissions targets is measured
- n Emissions and Sinks reporting under the Kyoto Protocol during the commitment period 2008-2012 have value (money)
- n Mitigation actions which cannot be shown to achieve the emissions reductions to the standards required by the UNFCCC review panels will not be counted towards the targets

# UNFCCC Reporting Kyoto Protocol Accounting

- n UNFCCC Reporting
  - n All anthropogenic emissions and sinks
  - n All years since 1990
  
- n Kyoto Accounting
  - n **Agreed sub-set of emissions and sinks**
  - n Article 3.3 mandatory for Annex I countries
  - n Base year 1990 (x5)
  - n Emissions summed over 5 year (2008-2012 inclusive)
  - n Additional measures since 1990
  
- n Natural emissions and sinks are not included in either
  - n KP include mention of preservation of carbon stocks but only deforestation is accounted.



## Kyoto reporting

### Article 3.3

Mandatory accounting of any Afforestation, Deforestation and Reforestation which has occurred since 1990.

### Article 3.4

Four land management activities are allowable, if the party elects

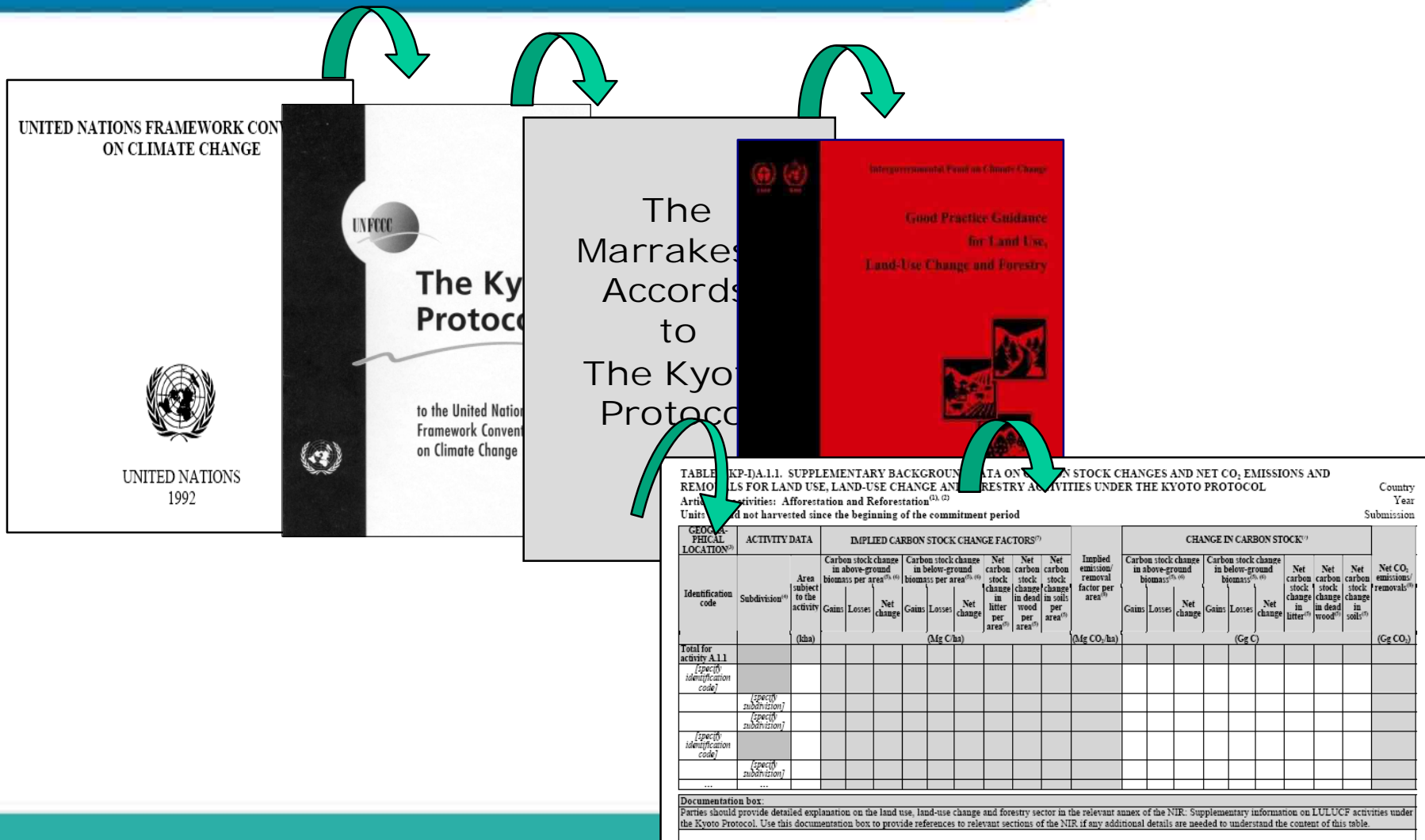
Forest management

Grazing land management

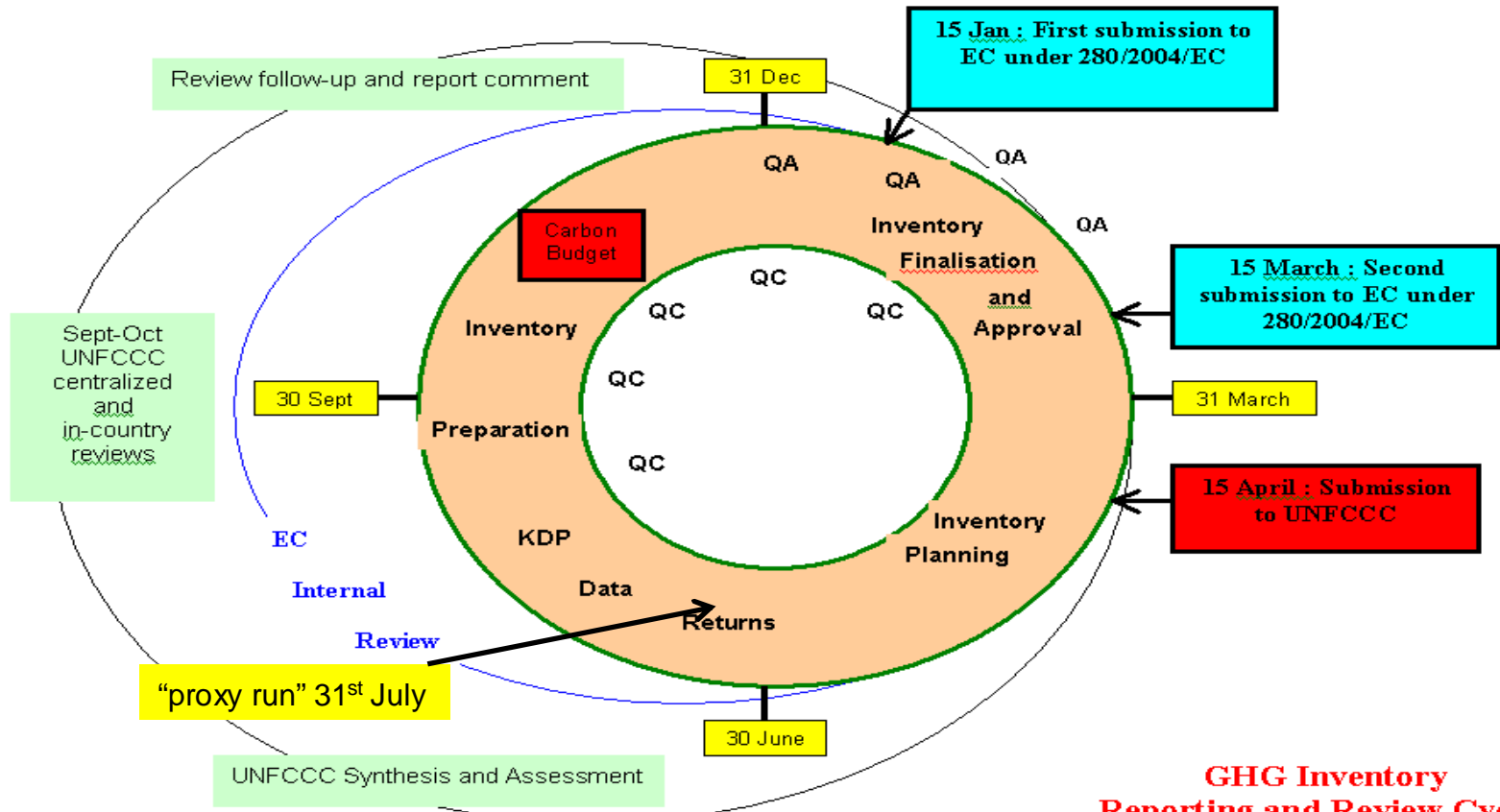
Cropland management

Revegetation

# The Rule Books



# Annual Cycle for Reporting



Official 15 month lag for UN submission  
 12 months for EU submission /review  
 11 months for Carbon Budget in December

# Key Data Providers

Key Data Provider	Data Supplied	Deadline	IPCC Sector in which data are used
Sustainable Energy Ireland	National Energy Balance; Detailed energy consumption by sector and fuel	30 September	Energy, Waste
Dept of Agriculture and Food	Cattle populations from CMMS <sup>1</sup> , fertilizer sales	30 September	Agriculture
Central Statistics Office	Livestock populations, crop statistics, human population, housing data	30 September	Agriculture, Industrial Processes, Waste
COFORD <sup>2</sup>	Estimates of CO <sub>2</sub> emissions and removals and other GHG emissions for forest land; Statistical data on afforestation, reforestation and harvesting;	30 September	LULUCF Kyoto Art 3.3
Bord Gais	Analysis results for indigenous and imported natural gas	30 September	Energy
Marine Institute	Annual Report on Discharges, Spills and Emissions from Offshore Gas Installations	30 October	Energy
ETU	Verified CO <sub>2</sub> estimates and related data for ETS installations	30 April	Energy, Industrial Processes
*Dept Communications, Energy and Natural Resources	National Oil Balance (as a component of the energy balance)	30 September	Energy
*Road Safety Authority	Road transport statistics from the National Car Test (NCT)	30 April	Energy

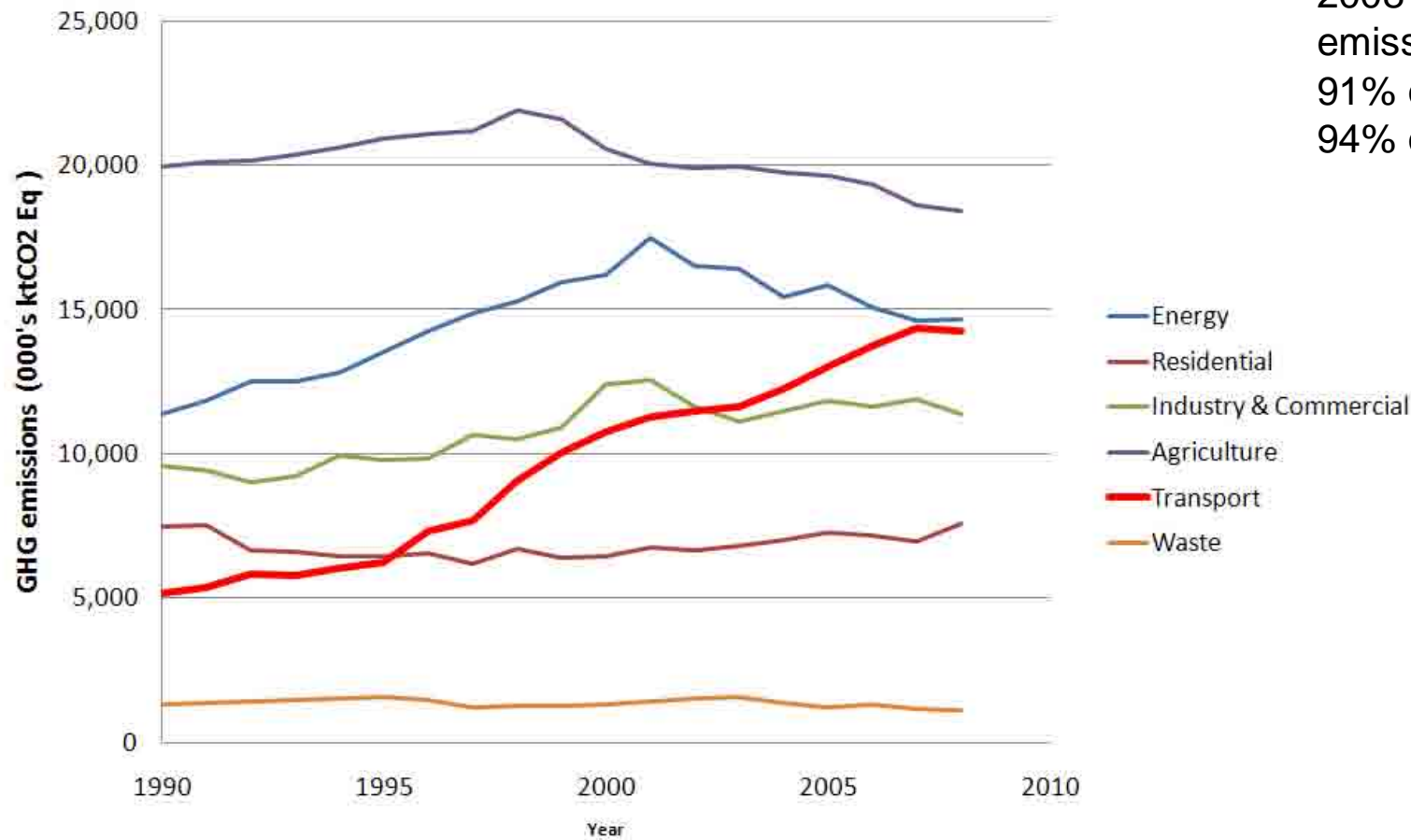


# Agriculture Land Use, Land Use Change and Forestry

- The IPCC Agriculture sector includes five sources of GHG emissions
  - Domestic Livestock: Enteric fermentation
  - Manure management
  - ~~Rice Cultivation: Flooded Rice Fields~~
  - ~~Prescribed Burning of Savannas~~
  - Field Burning of Agricultural Residues (banned)
  - Agricultural Soils
- LULUCF
  - **Forestry**
  - Cropland
  - Grassland
  - Wetlands
  - Settlements
  - Other lands

# NIR 2010 Emission for 1990 to 2008

## Sectoral Breakdown of National Emissions



2008 Agriculture emissions are  
91% of 1990 emissions  
94% of 2005 emissions

## Relationship between Dairy and Beef animals and GHG emissions

As per Inventory 2010

	Enteric Fermentation kg CH <sub>4</sub> head <sup>-1</sup> yr <sup>-1</sup> (CO <sub>2</sub> eq)	Manure management kg CH <sub>4</sub> head <sup>-1</sup> yr <sup>-1</sup> (CO <sub>2</sub> eq)	Manure Management N excreted kg N <sub>2</sub> O head <sup>-1</sup> yr <sup>-1</sup> (CO <sub>2</sub> eq)	Total CO <sub>2</sub> Equivalent
Dairy animal	110 (2,310)	20.5 (430)	1.7 (520)	3.25 t
Non dairy	55 (1,155)	11.3 (227)	1.4 (430)	1.82 t

In addition there is a strong correlation between animal emissions and direct emission of N<sub>2</sub>O from soils due to use of artificial fertiliser: 0.9 t CO<sub>2</sub> eq head<sup>-1</sup> yr<sup>-1</sup>



# Inventory Methodology

## Tier 1

A **simple** first order approach that uses spatially coarse **default** data characterised by large uncertainties and with methods involving several simplifying assumptions (IPCC guidelines);

## Tier 2

A more accurate approach substituting **country specific values** and appropriately disaggregated activity data;

## Tier 3

Higher order methods involving detailed modeling and/or measurement systems driven by data

# Tiers in NIR Ireland

## Agriculture and LULUCF

Sector		CO2	CH4	N2O
Agriculture	Enteric Fermentation		T2,T1 CS,D	
	Manure Management		T2,T1 CS,D	T1 D
	Agricultural Soils			T1a,T1b CS, D
LULUCF	Forestry	T3, T1 CS,D	T1 D	T1 D
	Cropland	T1 D		T1 D
	Grassland	T1 D		
	Wetlands	T1 D		T1 D
	Settlements	T1,T2 D,CS		
	Other	T1 D		



## Golden Rule of Emission Estimation

Emissions = Activity Data \* Emission Factor

Tier 1: Direct Emissions of N<sub>2</sub>O due to Artificial Nitrogen application in Agriculture

N<sub>2</sub>O emissions = Sales of Nitrogen Fertilisers \* EF (0.0125%)

# Golden Rule of Emission Estimation

- n Tier 3
- n Forest Sink

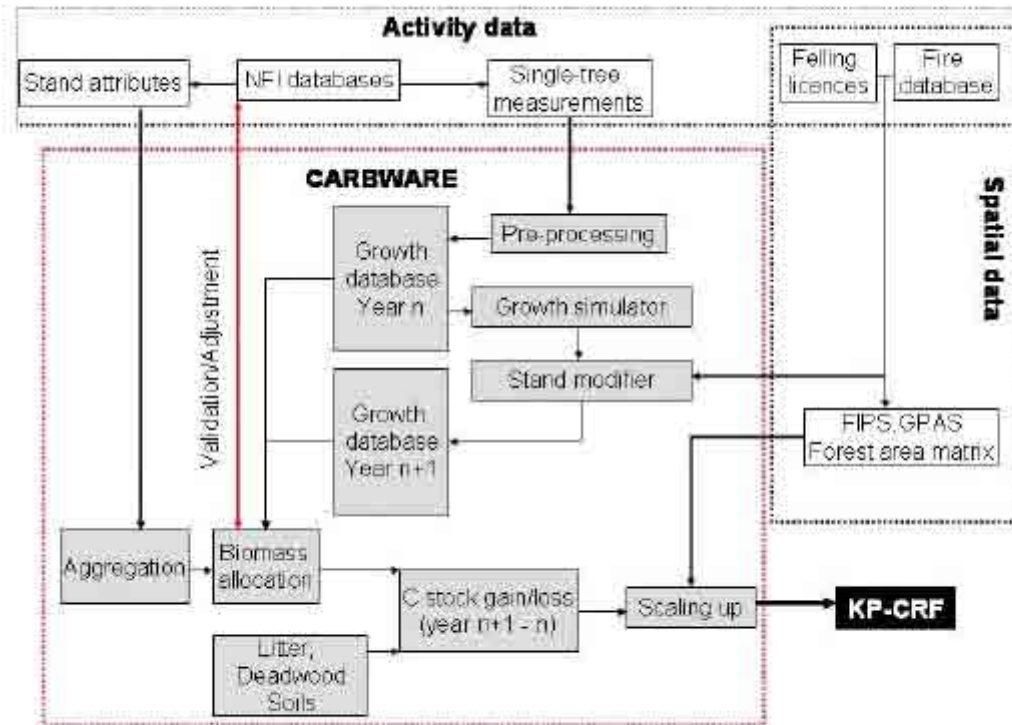
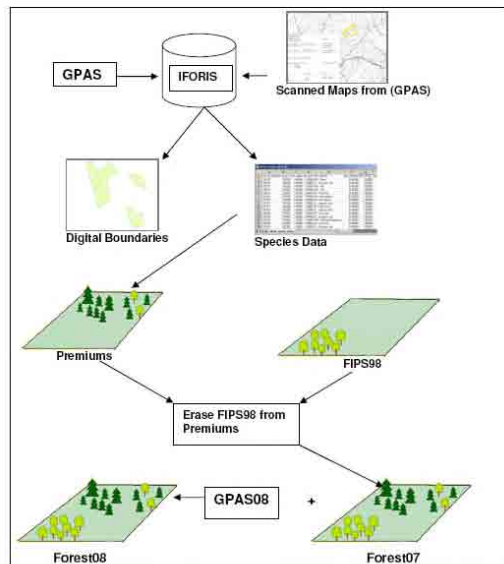


Figure 11.1: Schematic Overview of Reporting System and CARBWARE Functionality

NIR 2010

## Current Developments

- n Inventory development relevant to Agriculture and LULUCF
  
- n N<sub>2</sub>O Croplands steps towards Tier 2
- n N<sub>2</sub>O Grasslands and
- n Carbon emissions and sinks:
  - n Dr. Ibrahim Khalil -Research fellowship
  
- n Research call 24<sup>th</sup> June 2010
  - n Remote sensing of biomass in Irish Landscape
  - n Carbon emission from drained organic soils under grass

## Revising N<sub>2</sub>O Croplands

- n Tier 2
- n Conventional and Non Inversion Tillage in Ireland, CCFLUX report
- n EF proportional to N Fert. Usage
- n Fertiliser Usage Survey
  - n 1995,2000,2004-2008
- n CSO area under cereals
- n Between 10-15% of N Fert use
- n DAFF N-Fert sales

STRIVE Report 43 - Mike Jones et al.  
<http://www.epa.ie/downloads/pubs/research/climate/name,27813,en.html>

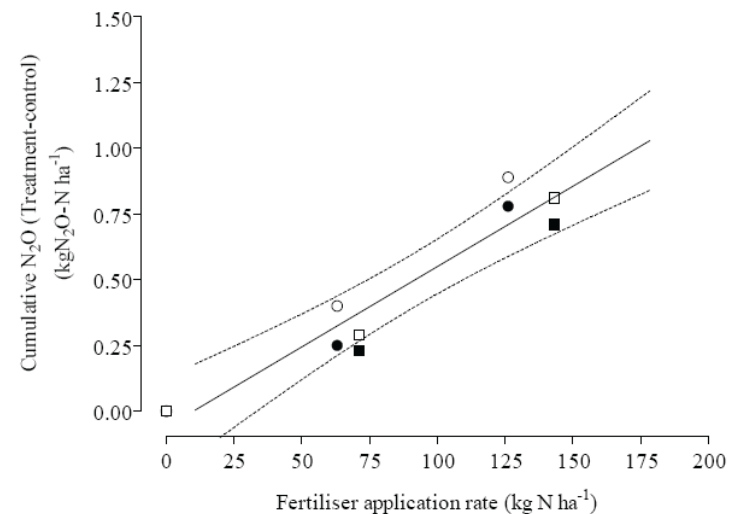


Figure 4.5. Relationship between fertiliser application rate and cumulative N<sub>2</sub>O flux over the growing seasons 2004 and 2005. Each point represents the mean  $\pm$  SE of 4 values. Symbols indicate: CON 2004 (●), NIT 2004 (○), CON 2005 (■) and NIT 2005 (□).  $Y = 0.0061 \pm (0.0008) \times -0.0613 \pm (0.0079)$  and ( $r^2 = 0.77$ ).

## Tier 2 N<sub>2</sub>O Croplands (in prep.)

Changes in fertiliser use and changing land use areas under **cereals** are reflected in the inventory

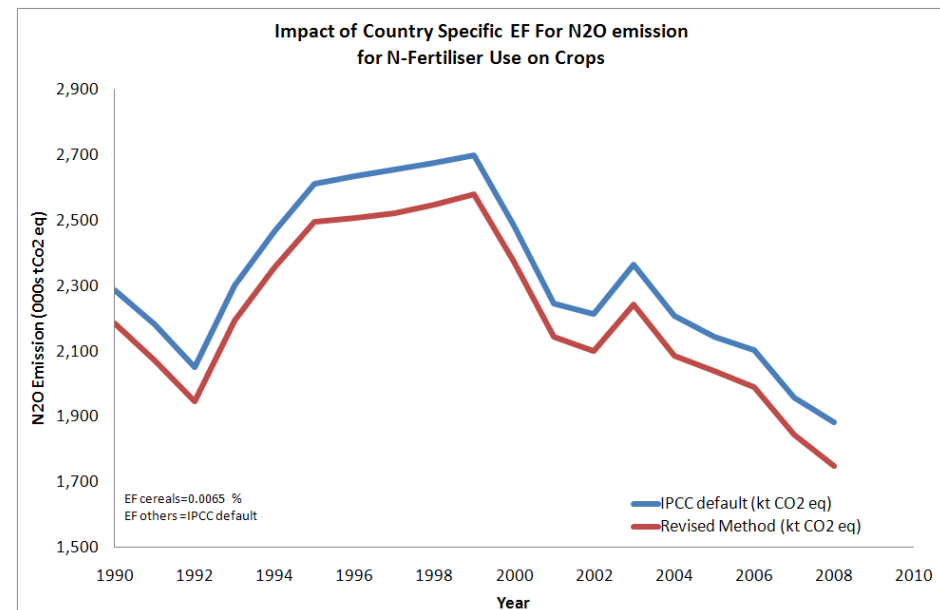
Consistency with Ammonia Inventory methodology

N<sub>2</sub>O default= Sales of N Fert \* EF (1.25%)

N<sub>2</sub>O revised= N Fert<sub>App</sub> (Sales, Fertiliser Use, CSO Area) \* EF (Cereals=0.65%, Others= IPCC default)

A reduction of in 2008 of 132 ktCO<sub>2</sub> eq

@ €15 per t CO<sub>2</sub>, saving of €1.9m, or €9.5m over the 5yr commitment period

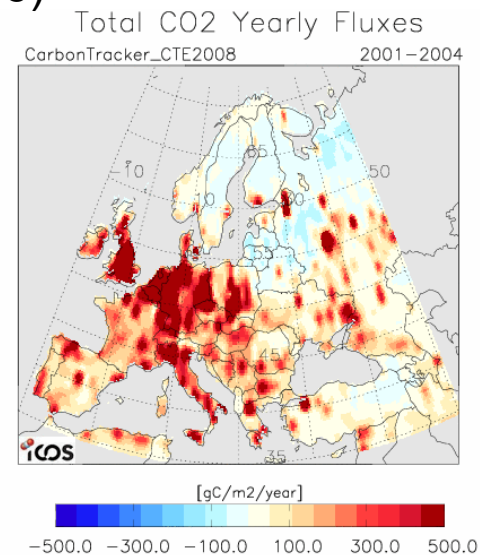


## Soil carbon dynamics in Grasslands

EPA funded recent research findings indicate that managed well established grasslands may be sequestering carbon to soil (Kiely, 2009)  
approx  $1 \text{ tC ha}^{-1} \text{ yr}^{-1}$  or  $3.6 \text{ t CO}_2 \text{ eq}$

The research was linked with wider European, average sink  $0.5 \text{ tC ha}^{-1} \text{ yr}^{-1}$  (CarboEurope, 2008)

But caution is need.  
Significant interannual variability



A longer time period to establish useful average uptake is required.  
Representative?

## Soil carbon Caution

Carbon uptake to grassland soils:  $1\text{tC ha}^{-1}\text{ yr}^{-1}$  or  $3.6\text{ t CO}_2\text{ eq}$

This is of the same order as the inventory emissions of GHG per animal

Can this sequestration of carbon be include in the Inventory?

### **Yes:**

Within UNFCCC LULUCF changes in carbon stock in grasslands remaining grasslands can be reported. There would be a requirement to produce a **complete** national estimate of emissions and sinks. Drained organic soils may prove to be a significant source of emissions

### **No:**

Under Kyoto Protocol, Ireland does not account for Art 3.4 activities  
Additionality rules would probably negate of the grassland sink

## The Future

- n Inventory rules will change through negotiation
- n Especially in the area of Land Use
  
- n Reporting
  - n integration of Agriculture and LULUCF
  - n Agriculture Forestry and Other Land Use (AFOLU)
  
- n Accounting
  - n Mandatory new activities under Article 3.4
    - n Forest Management
    - n Grassland; Cropland; Wetland management, Revegetation

# Conclusions

Can emission reduction option, efficiencies and uncertainties be reported in the inventories?

Yes, but there is a need for continued research, activity data collation and inventory development to achieve this.

Does soil carbon sequestration negate the need to reduce emissions?

The current rules do not favour this approach. However there may be options via the carbon market but this needs further and careful consideration



Thank you!

Questions?



## Alternative thinking Voluntary Carbon Market

A national requirement to meet emissions reduction targets will not provide an incentive to quantify, incentivise or reward soil carbon sequestration in most instants

The voluntary market is not bound by the rules of the UNFCCC

The VM want credibility

- additionality may not be an issue,  
not risk adverse

- the price paid for the carbon sequestered to the soil will reflect the confidence the VM has in the magnitude and permanence of the sink



## Soil Carbon and grasslands

Article 3.4 and the additionality rule

The Net-Net accounting rules boil down to:

Only changes in the **rate** of carbon uptake/loss since 1990 can be accounted

A comparison between the carbon dynamics in a grassland area in 1990 and the same area “now”

Except the area of managed agricultural grassland in Ireland has fallen. Therefore Ireland has lost a sink of carbon relative to the base year in 1990.

It may be that modern management practices have increased the magnitude of the annual sink, but by how much?

It will be very challenging to roll out a national inventory methodology for soil carbon  
The opportunity may be open for private sector involvement

## Article 3.4 Activities

- “Revegetation” is a direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of afforestation and reforestation contained in article 3.3
- “Forest management” is a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner
- “Cropland management” is the system of practices on land on which agricultural crops are grown and on land that is set aside or temporarily not being used for crop production
- “Grazing land management” is the system of practices on land used for livestock production aimed at manipulating the amount and type of vegetation and livestock produced

## Data sources- Agriculture

- n Emission factors
  - n CH<sub>4</sub> - national research
  - n N<sub>2</sub>O - default Tier I IPCC Guidelines
- n Animal population statistics - C.S.O., C.M.M.S.
- n N excretion - NO<sub>3</sub> Directive, DAFF/ Teagasc
- n Manure Management Practices - DAFF/Teagasc
- n Crop production statistics - C.S.O.
- n Fertilizer Use Statistics - DAFF/Teagasc
- n Sewage Sludge - EPA

# The Gases and Global Warming Potential

Industrial Designation or Common Name (years)	Chemical Formula	Lifetime (years)	Radiative Efficiency (W m <sup>-2</sup> ppb <sup>-1</sup> )	Global Warming Potential for Given Time Horizon			
				SAR† (100-yr)	20-yr	100-yr	500-yr
Carbon dioxide	CO <sub>2</sub>	See below <sup>a</sup>	<sup>b</sup> 1.4x10 <sup>-5</sup>	1	1	1	1
Methane <sup>c</sup>	CH <sub>4</sub>	12 <sup>c</sup>	3.7x10 <sup>-4</sup>	21	72	25	7.6
Nitrous oxide	N <sub>2</sub> O	114	3.03x10 <sup>-3</sup>	310	289	298	153

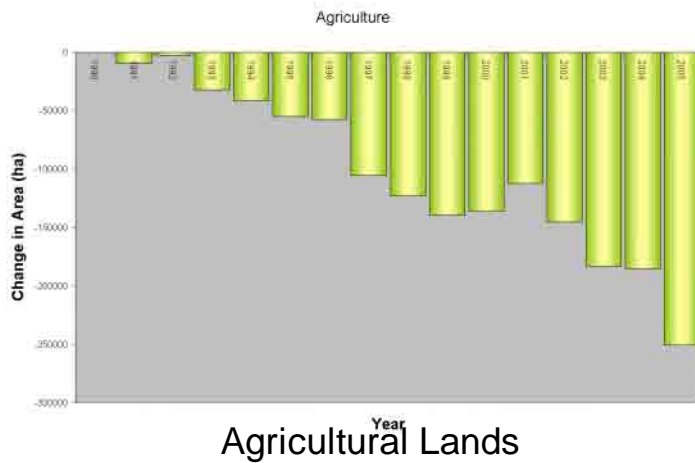
It is non-trivial exercise to benchmark the impact of emissions of different GHG gases

The parties to the UNFCCC agreed that GWPs<sub>100</sub> from the Second Assessment Report (1995) be used for inventory purposes

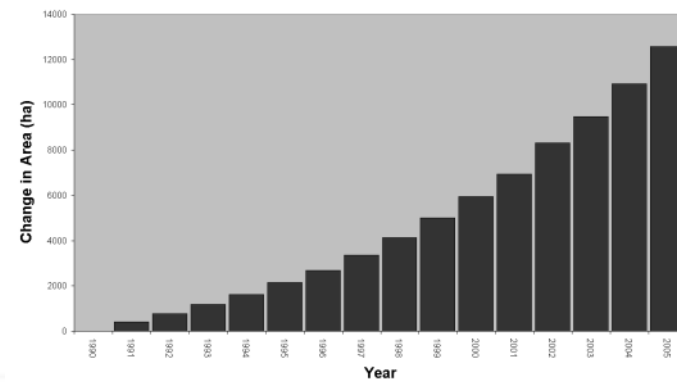
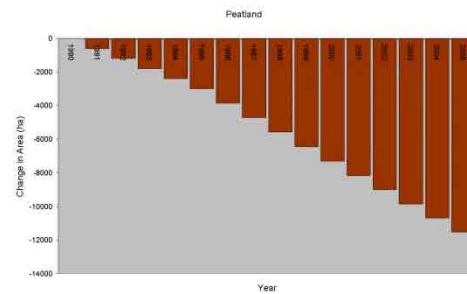
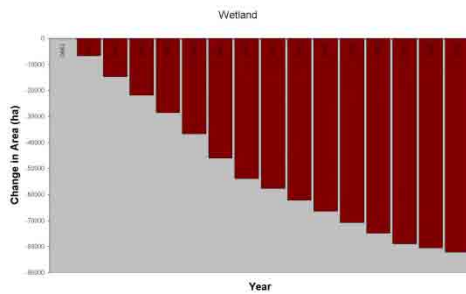
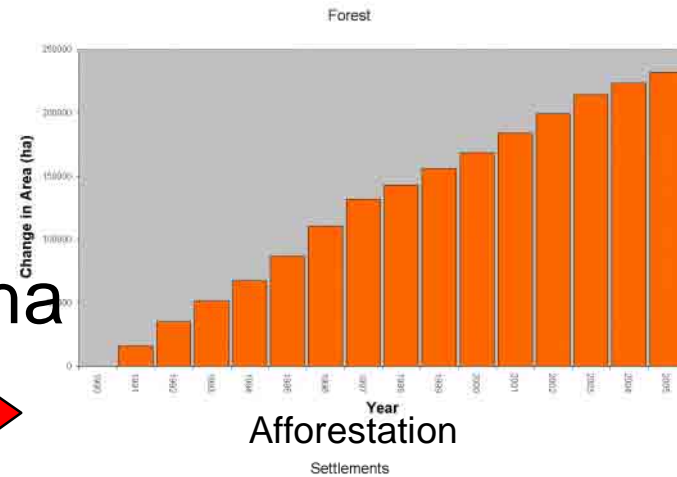
Other metrics have been proposed, such as Global Temperature Potential or Global Damage Potential. However, as yet, these don't have the scientific rigor of GWP.

# Land Use Change in Ireland

The pattern of changing land use in Ireland. Agricultural and Wetlands have been converted to forestry and, a lesser extent, to Settlement.



~250,000ha



## N<sub>2</sub>O emissions

- n Characteristics of Grasslands in Ireland
  - n 90% of Agricultural land, key source
  - n Multiple soil types
  - n Spatial variability in meteorological influences
  - n Multiple applications rates and methods
  - n Poor activity data e.g. grazing history
  
- n Characteristics of cereals production in Ireland
  - n Limited area (<10% agricultural land), not a key source
  - n Limited variability in soil types
  - n Geographically well defined areas
  - n Rates of application of fertiliser are known
  - n Reasonable activity data

## Revising N<sub>2</sub>O and Carbon emissions /sinks Grasslands

- n Challenging
- n Developments in modelling of N and C cycles in agriculture
- n Strategic research projects EPA, DAFF, Teagasc
- n European studies such as NitroEurope, CarboEurope
  
- n Research Fellowship: Dr. Ibrahim Khalil
  - n Collate existing research
  - n Develop methodology to scale up field results and models
  - n Include mitigation options
  - n Consistency between N<sub>2</sub>O, Carbon and Ammonia activity data
  - n Contact and collaboration with research community