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"*Transforming Emission Inventories - Meeting Future Challenges Today*"

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Supporting Spain's national emission projections with the EmiPro tool

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MINISTERIO DE MEDIO AMBIENTE

Supported by the Spain's Ministry of Environment

OUTLINE

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3. SPAIN'S EMISSION PROJECTIONS (SEP) PROJECT
4. THE EmiPro TOOL
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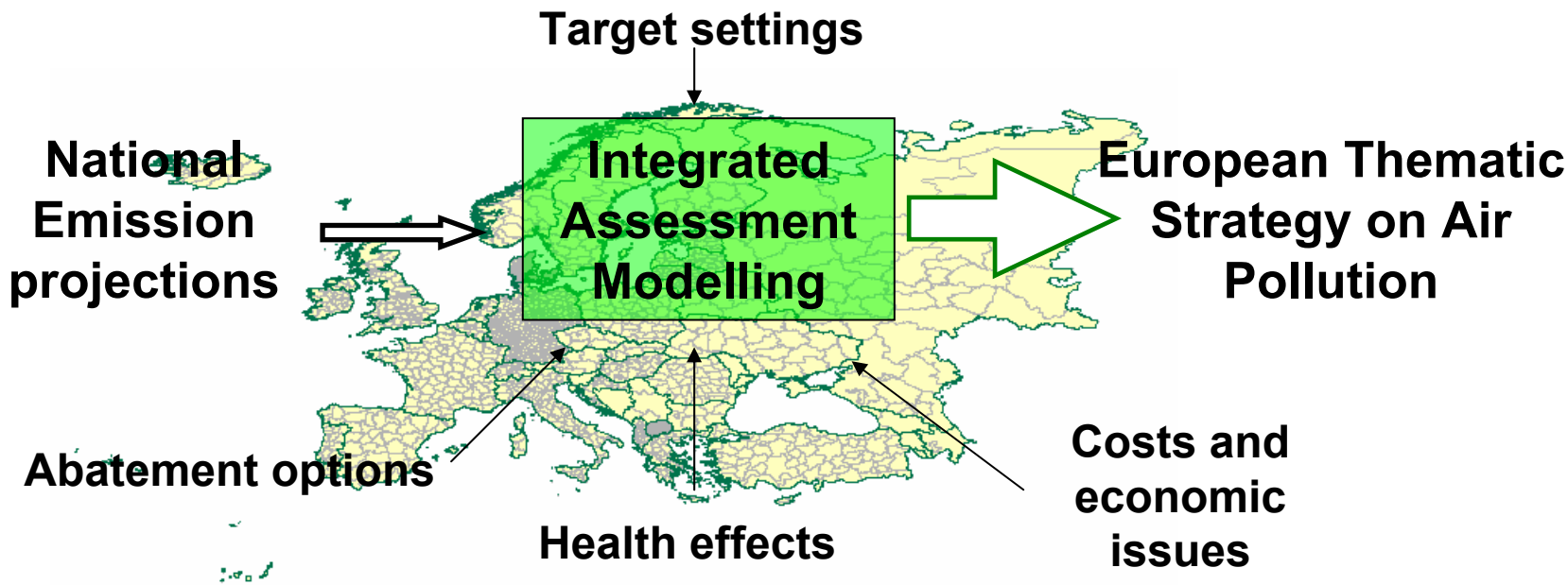
1. INTRODUCTION

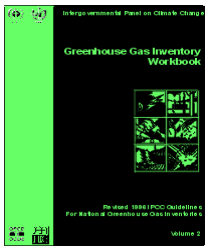
- Emission projections have become an essential tool in supporting environmental policy design and decision making

- Compulsory requirement for the Member States under the CAFE (Clean Air For Europe) program



- Better national Emission Inventories:

  - Clear and detailed methodologies and standars for compilation and submission of National Emission Inventories



IPCC Guidelines for National Greenhouse Gas Inventories

WMO INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE National Greenhouse Gas Inventories Programme UNEP

EMEP/CORINAIR Emission Inventory Guidebook

emep

European Environment Agency
Information for improving Europe's environment

LRTAP 25th Anniversary
Long-range Transboundary Air Pollution

UNFCCC

- These enhancements have somehow reached Emission Projections, but there are still many issues to address:
  - Lack of reference procedures for National Emission Projections development
  - Compatibility with National Emission Inventory
  - Consistency and completeness
  - Reliability and uncertainties
  - Update methodologies
  - Submission schedule

?

2. BACKGROUND

Spain's National Emission Inventory

- It is based on the CORINAIR methodology.

- It relies on the SNAP nomenclature (Selected Nomenclature for Air Pollution), harmonized with the IPCC/OECD and EMEP/UNECE ones. This classification has a hierarchical structure based on the following three levels: Group (11) > Sub-group (76) > Activity (430)

Example (SNAP activity 010101)

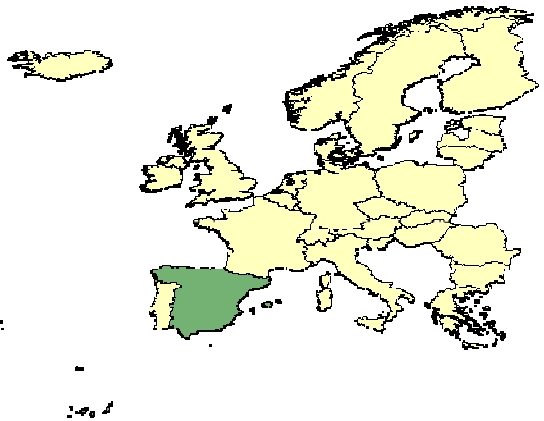
Group = 01 (Combustion in energy and transformation industries)

Subgroup = 01 (Public Power)

Activity = 01 (Combustion Plants ≥ 300 MW (Boilers))

- Temporal resolution: yearly
- Spatial resolution: province (NUTS-3 level according to the European geographical administrative classification provide by EUROSTAT, the European Statistical Office)

Nomenclature des Unités Territoriales Statistiques



NUTS 0 - Countries

NUTS 2 - Autonomous Regions

NUTS 3 - Provinces

Legislative aspects

- There are two fundamental references that determine the conception of the SEP project and the design of EmiPro:

Kyoto Protocol

- Spain is legally bound to achieve its targets for green house emissions according to the recently entered into force Protocol:

Year	CH_4	CO_2	N_2O	HFC	PFC	SF_6	Total
1990	31982	224471	26465				282918
1995				4645	790	94	5529
Total Kyoto Protocol Base Year							**288447**
Spain's Kyoto Protocol Target for the first period of compromise (assumed 2010)							**331715**

Kyoto Protocol base year GHG emissions and emission target for Spain. All figures are in kt of CO_2 equivalent.

- All the GHG emissions released in the national territory are accounted for the Protocol

- The "flexibility mechanisms" are not taken into account in the SEP project, so that the +15% target is considered

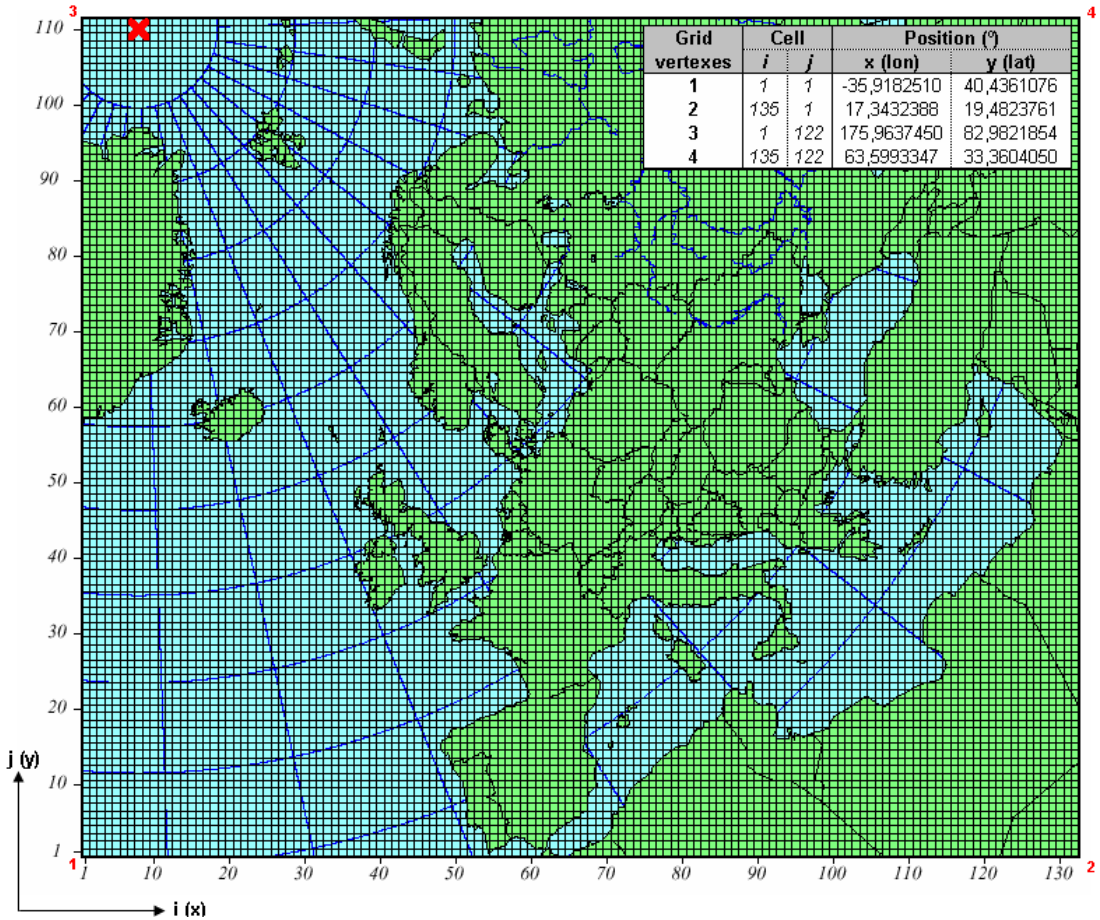
EU National Emission Ceiling Directive (NEC Directive)

- The Directive 2001/81/EC is intended to reduce the emission of acidifying, eutrophying and photochemical air pollutants precursors across Europe.

Pollutant	Emission (kt)
SO_2	746
NO_X	847
NMVOC	662
NH_3	353

Spain's National Emission Ceilings for 2010

- Only anthropogenic emissions are computed, so emissions from SNAP group 11 (nature) and the NMVOC from group 10 (agriculture) are not taken into account



Grid vertexes	Cell i	Cell j	Position (°) x (lon)	Position (°) y (lat)
1	1	1	-35,9182510	40,4361076
2	135	1	17,3432388	19,4823761
3	1	122	175,9637450	82,9821854
4	135	122	63,5993347	33,3604050

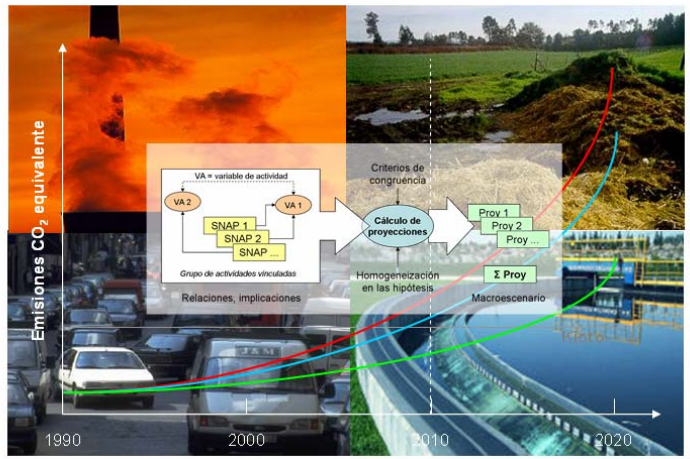
- The Directive is only applicable for the territories inside the EMEP grid ⇒ The Canary Islands are not affected by the NEC Directive

EMEP 50x50 grid system

3. SPAIN'S EMISSION PROJECTION (SEP) PROJECT

Aim and scope

- This project tries to fill all the gaps regarding national emission projections for the Spanish case



- The main aim of the SEP project is the development of useful information for policy decisions within the atmospheric pollutant emission field

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DIRECCIÓN GENERAL DE CALIDAD Y EVALUACIÓN AMBIENTAL

- Developed under contract with Spain's Ministry of Environment

Basic objectives

- To obtain emission projections for the period 2001-2020.
- To determine possible future scenarios
- To estimate the efficiency of the adopted measures in each scenario
- To evaluate the fulfilment of the Directives and the Protocols
- To integrate prospective studies and official plans and forecasts available for all the sectors covered in the study in a consistent way

Coverage

- The considered activities are all those included in the most up-to-date version (SNAP 97) of the SNAP nomenclature. The 2000 National Emission Inventory edition accounts for 282 SNAP activities.

- The pollutants projected are those included in:

  - the Geneva Convention: SO_X, NO_X, NH_3, NMVOC, CO, particulate matter (TSP, PM_{10} and $PM_{2,5}$), Pb, Cd and Hg.

  - the Kyoto Protocol: CO_2, CH_4, N_2O, PFCs, HFCs and SF_6.

Methodology

- Emission projections are fully-consistent with the Inventory. This usually means:

  -Same approach (bottom-up, top-down)

  -Same or compatible sources of information

  -Projection at SNAP-3 level (highest possible detail), or even at LPS (Large Point Source) level

Projections based on a wide range of particular methods and input information sources

- Reduction to a common basis (one of the two following simple algorithms):

$$E_i = A_i \cdot FE_a \cdot \prod_{j=1}^{n} FC_j \qquad E_i = G_{a-i} \cdot E_a \cdot \prod_{j=1}^{n} FC_j$$

E_i – Pollutant emission for year i
E_a – Pollutant emission for year a (base year, 2000)
A_i – Rate activity for year i
FE_a – Pollutant Emission Factor for the base year
G_{a-i} – Emission Growth Factor between years a and i
FC_j – Control Factors [0, 1] :

$$FC_j = 1 - R_j \cdot p_j$$

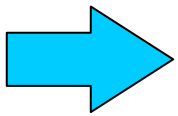
R_j – Abatement per j measure
p_j – Penetration of j measure

Scenarios

- A scenario is any combination of hypotheses regarding the values of each of the factors involved in the algorithms.

Considerations:

- Technological
- Socioeconomic
- Statistical
- Legislative



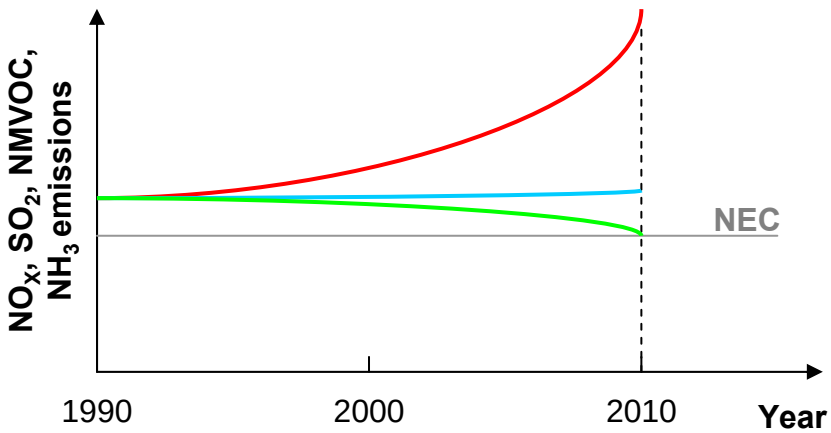
Hypothesis:

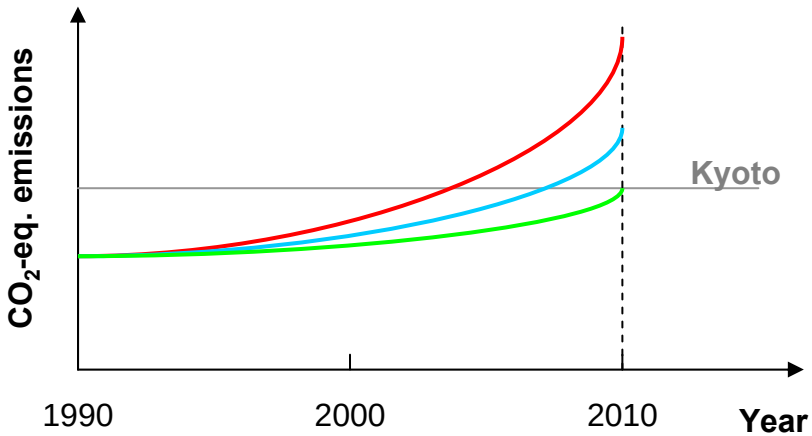
- Activity rate
- Emission factors
- Emission trends

= SCENARIO

- In order to standardize the procedure to define specific activity hypothesis and assure global consistency, three different types of scenarios have been identified to reflect three hypothetical situations that are interesting from the air quality management and decision making point of view.

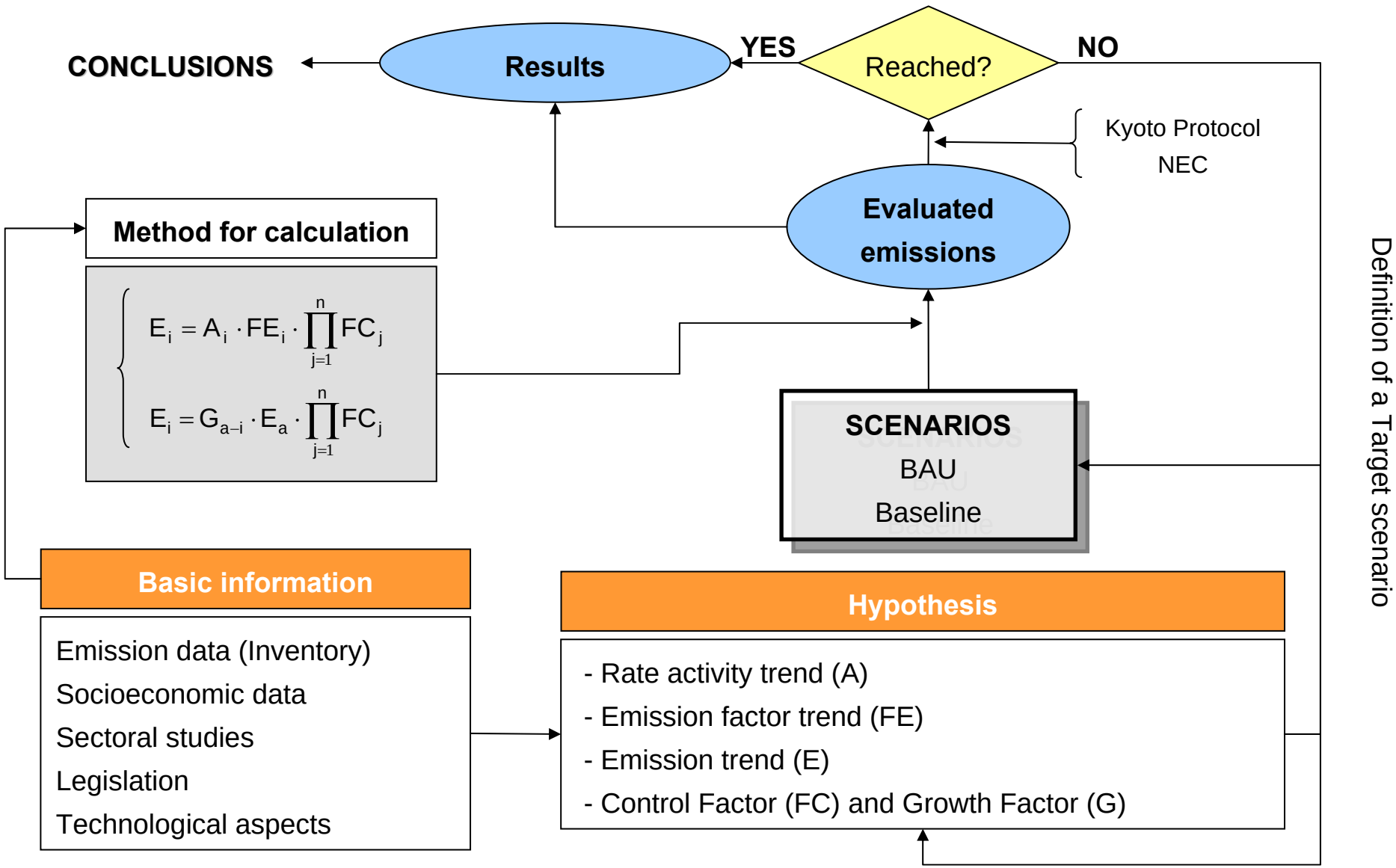
- In accordance with the CAFE criteria, the scenarios are divided into three general groups or types:





- **Business As Usual (Tendencial):** reference scenario without any measure taking into account the past emission trends.
- **Baseline (Base):** the more likely future situation considering the enacted legislation and adopted plans, measures and policies.
- **Target (Objetivo):** the environmental objectives are reached through additional measures (e.g. good practices, technical improvements, further policies, etc.).

- Specific methodology for the activity projection:



Databases

- Generally, projections are made on national basis:

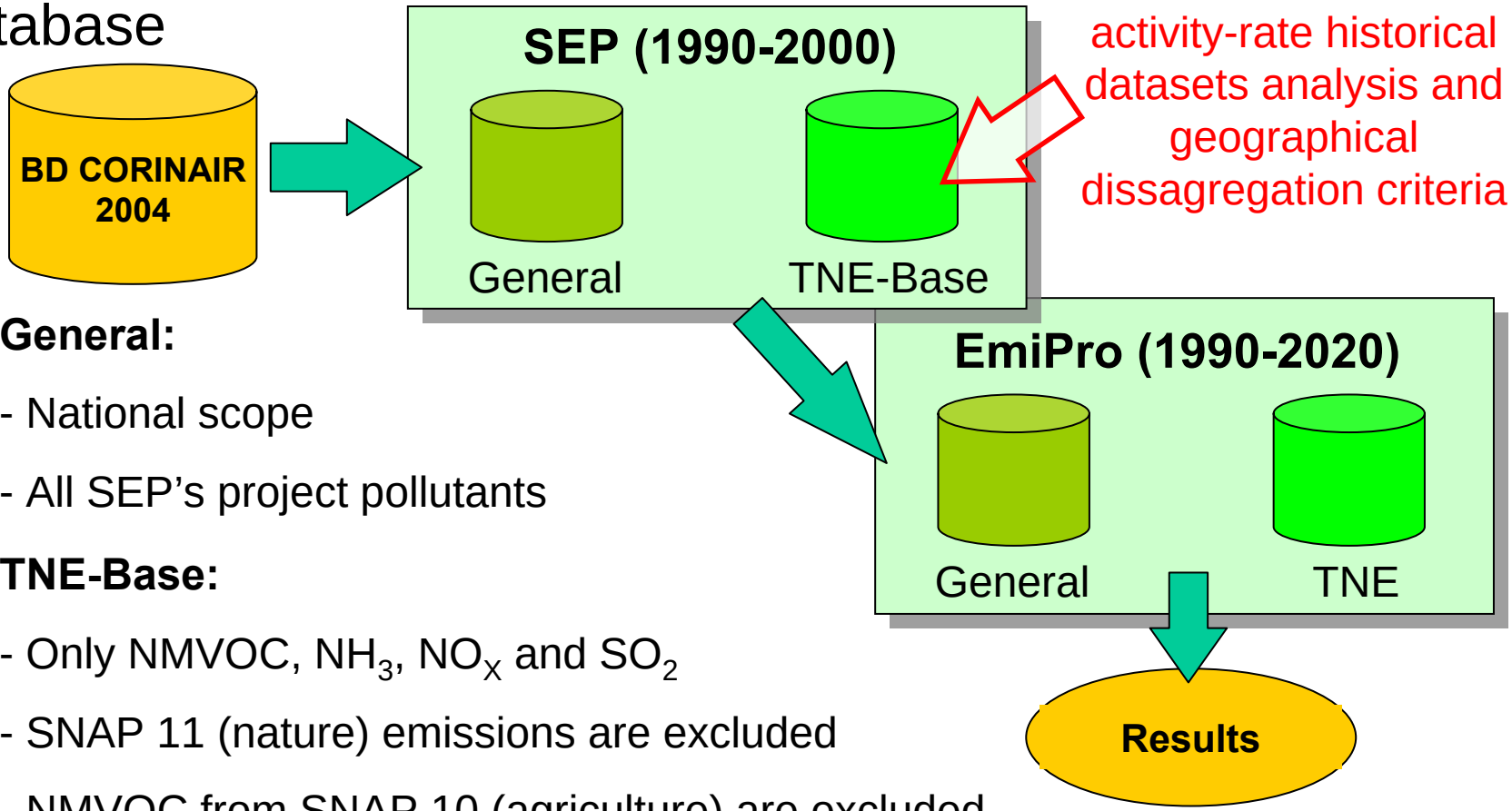
  ⇒ There is no need to keep NUTS-3 level information in the projections database

- But, the setting of thresholds derived from NEC Directive's commitments must be done taking into account only a subset of the total national emissions

Solution:

- Implementation of a parallel database system inside EmiPro corresponding to the two different geographic and pollutant scopes. None of them store NUTS-3 level information:

- Parallel projection scheme and information stored in each database



General:

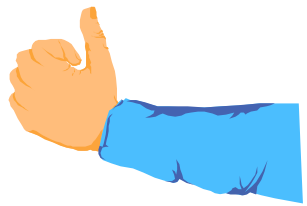
- National scope
- All SEP's project pollutants

TNE-Base:

- Only NMVOC, NH_3, NO_X and SO_2
- SNAP 11 (nature) emissions are excluded
- NMVOC from SNAP 10 (agriculture) are excluded
- Emissions under the EMEP domain (Canary Islands are not included)
- Domestic cruise traffic (h > 1000 m) emissions are excluded
- International airport traffic (LTO cycles<1000m) emissions are included

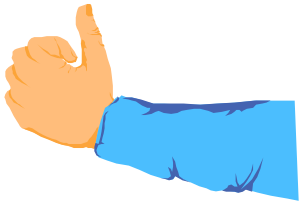
Integration criteria. Macroscenarios

- The emission projection methodology developed under the SEP project offers important advantages, but entails some disadvantages:

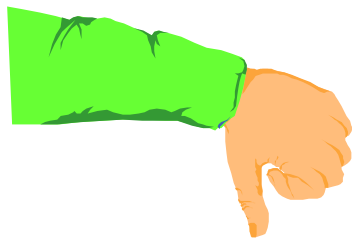


- allows the formulation of very specific, high-detailed hypotheses for each activity

- provides a useful framework to perform the assessment of the measures assumed under any scenario, both from the technical and the cost-efficiency points of view.



- Integration of prospective studies and official plans and forecasts available for all the sectors in a consistent way with the National Emission Inventory



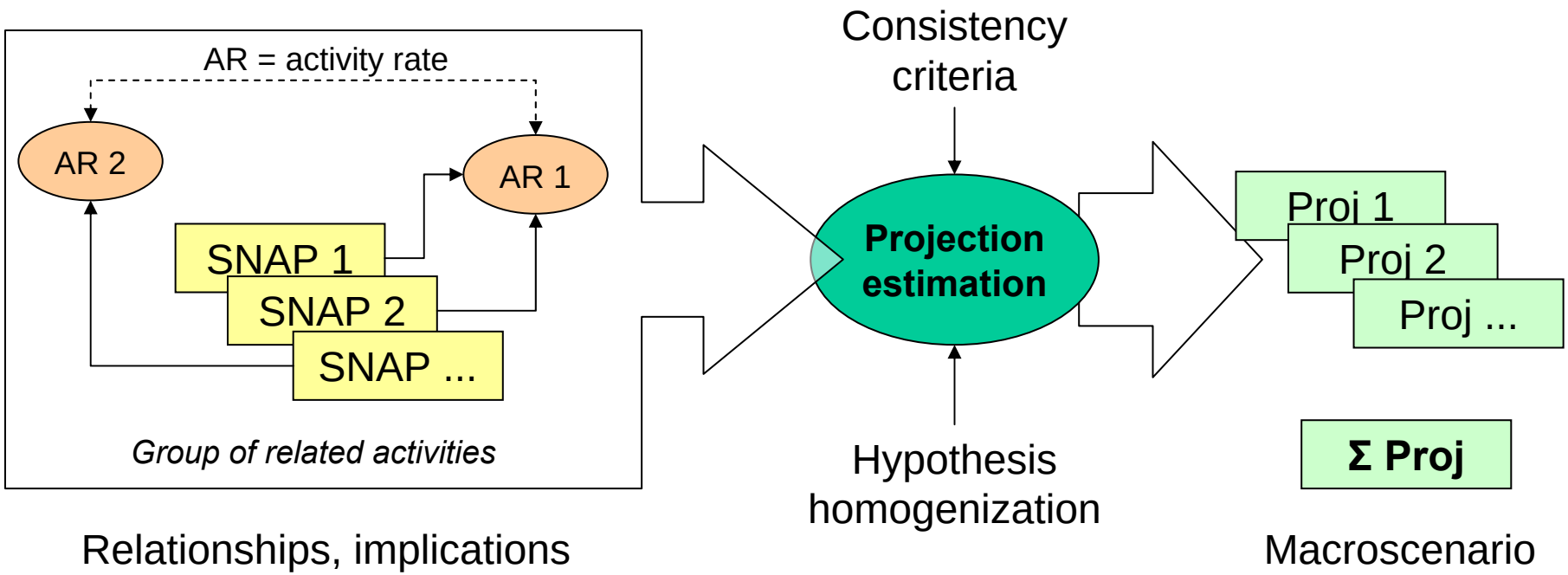
- Consistency among individual projections calculated through different methods and based on different input data
- Activity rate is an exogenous variable to the model
- Basic socioeconomic inputs or drivers such us GNP, interest-rates, population projections, etc. behind activity rate forecasts often are unknown

Some kind of QA/QC process is needed in order to guarantee the consistency when merging individual projections.

- The procedure developed to solve this problem is based on the analysis of the relationships existing among SNAP groups, subgroups and activities

- Any group of activities identified in having a clear connection through the activity rates involved in the emission estimation is called "Macroscenario". This name is also applicable to the joint projection of these groups of activities.

The macroscenario concept and individual results merging process:

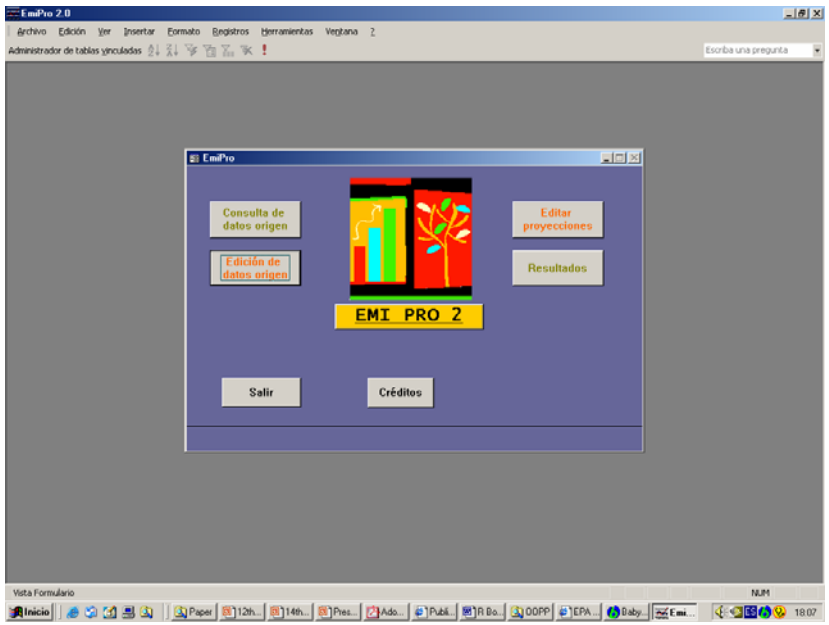


- Once the relationship mapping has been clearly identified, it is only a matter of introducing consistency conditions into the hypothesis made under each scenario for a particular activity rate

4. THE EmiPro TOOL

Overview

- EmiPro (for Emission Projection) is a software tool specifically developed to handle all the data and procedures involved in the SEP project.

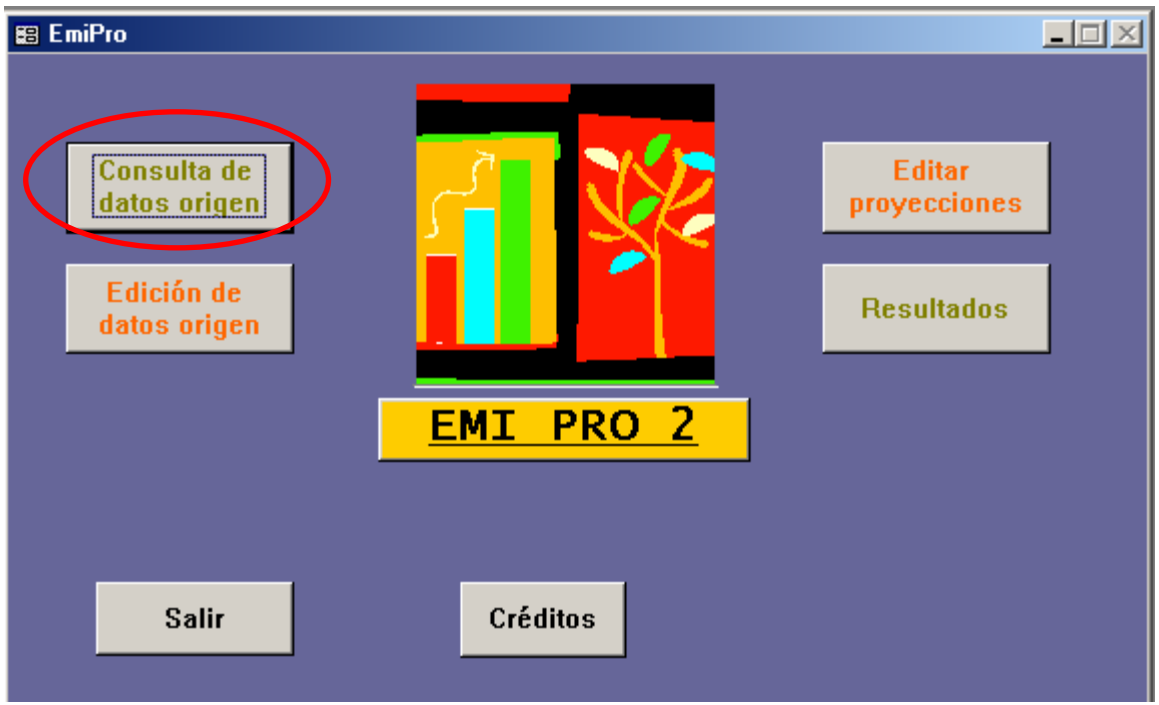


Last non-Beta version, currently v2.02

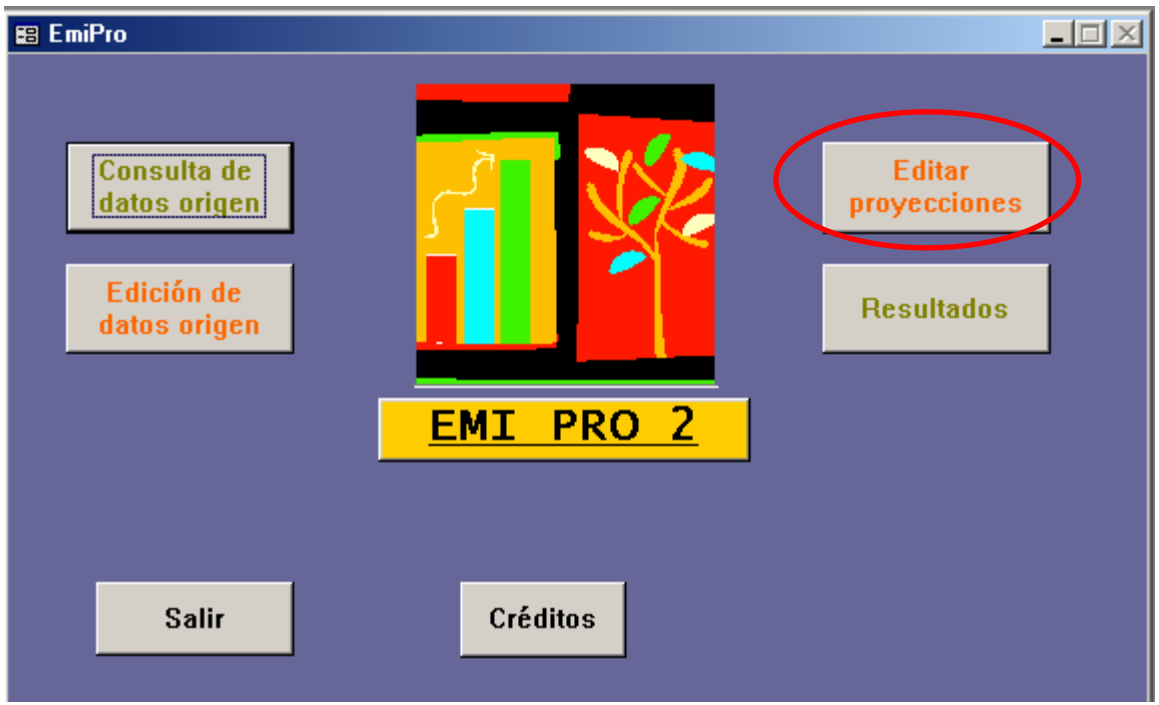
- Start screen -

- Its main functions are:

  -Storage and recovery of past (history) emissions

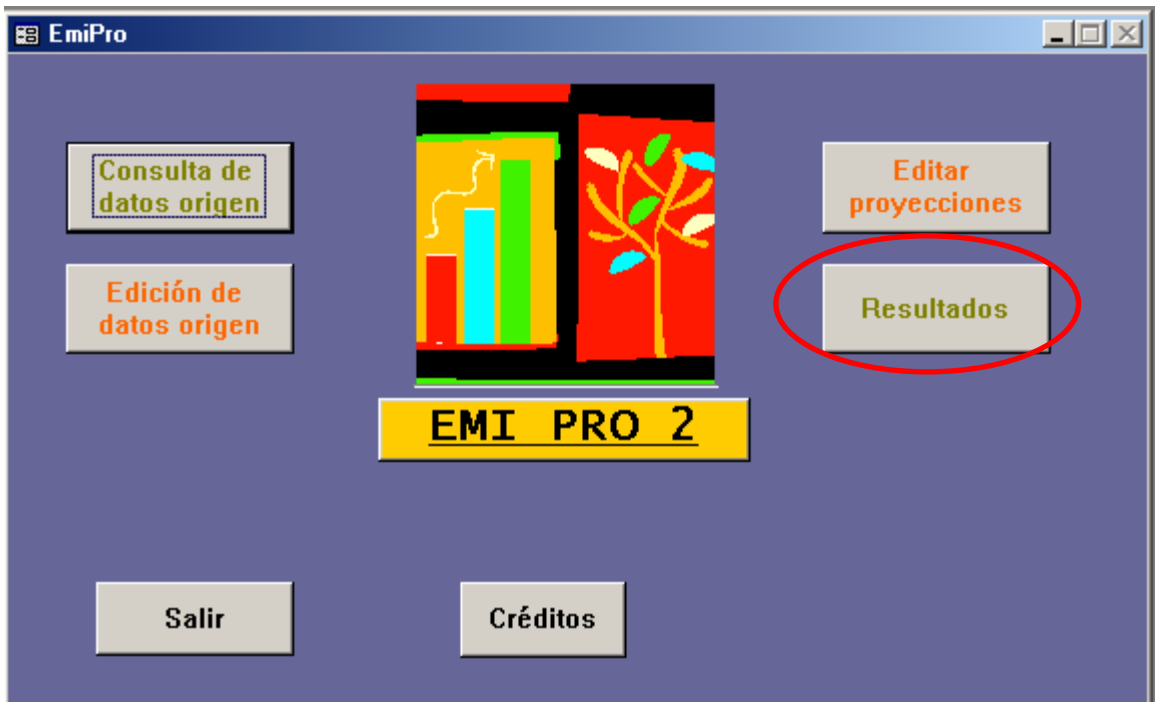


-Generation of projections from history data and algorithm factors



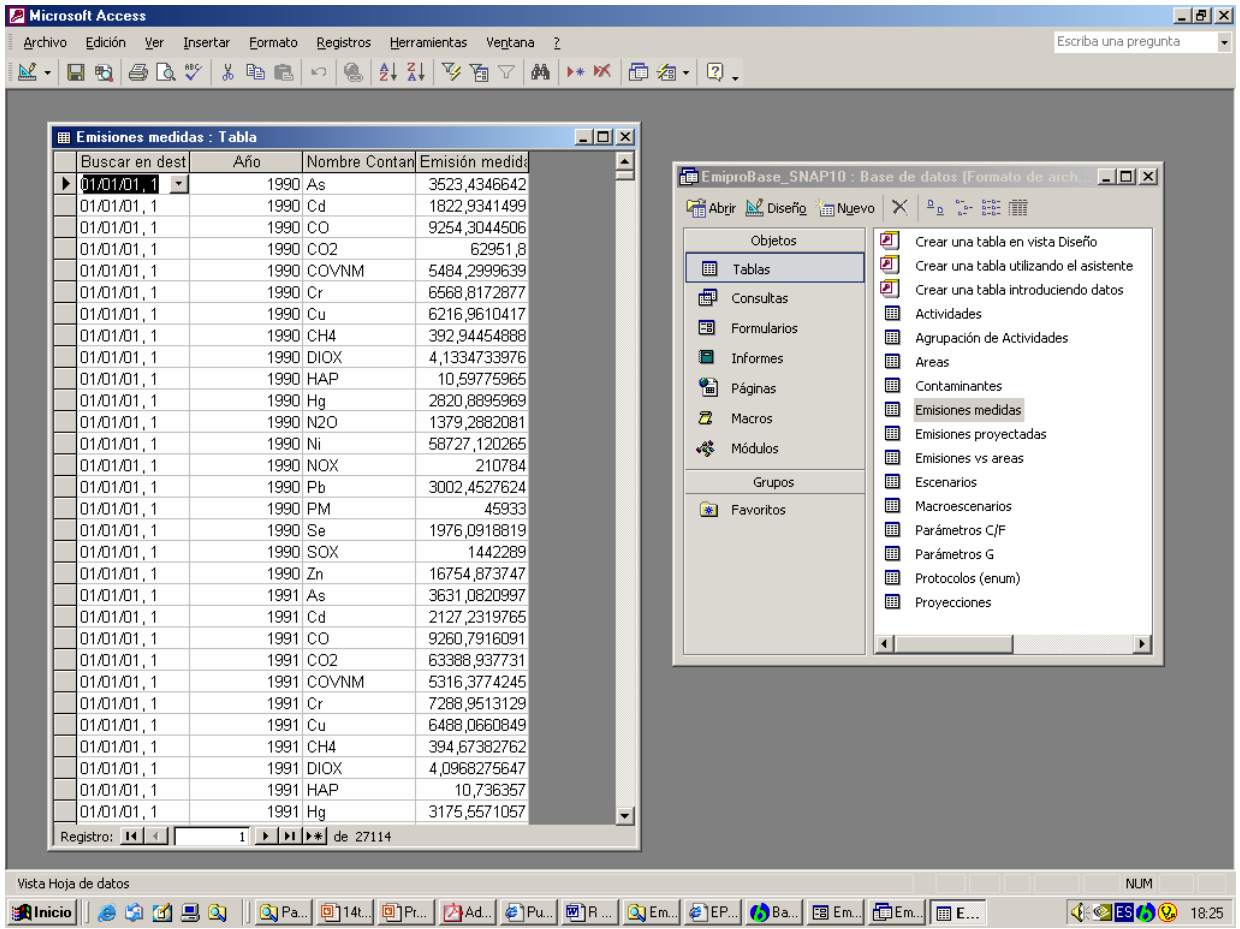
-Storage and recovery of projected emissions

-Reports generation



Working procedures

Massive data input



- Massive data input is made from past emissions series, as provided by the Spanish Environmental Administration (CORINAIR-database) ⇒ "General" database.
- Pre-processed past emission series ⇒ "TNE" database.

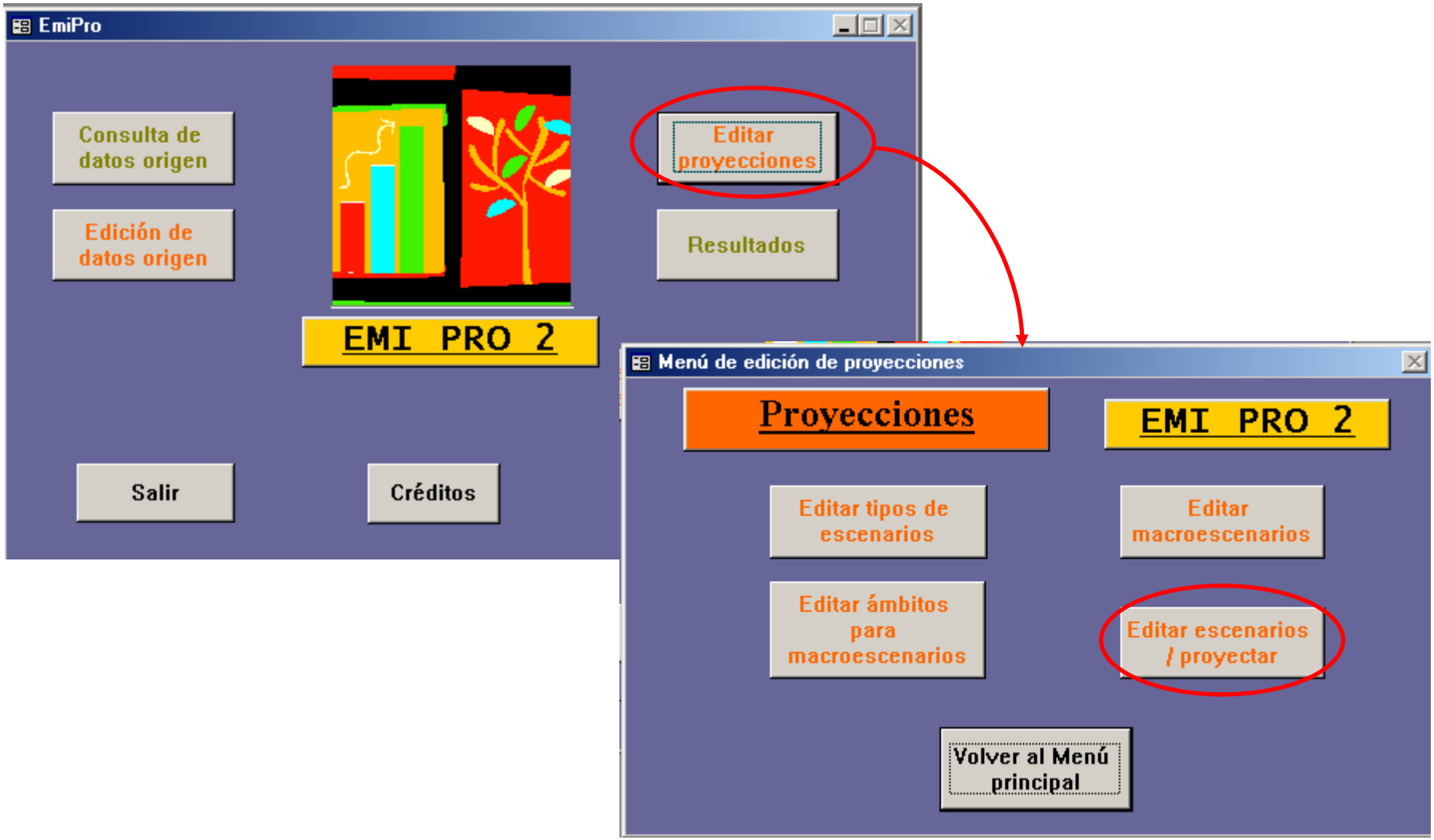
- Usually, once a year (Inventory updates)
- Massive feeding cannot be done in user mode
- Once information is loaded, reports are available for it. Editions and corrections of the information are also possible.

Projection parameters

- Parameter hypotheses for a given activity according to the selected algorithm are fed into Emipro, which loads them and automatically proceeds with the projections for the given activity and time frame:

Input requirements for single activity projection (for each scenario):

+ *MS™ Excel™ file containing two worksheets with the parameters to be used for the projection*
+ *MS™ Word™ file documenting the procedures and data used in the projection*

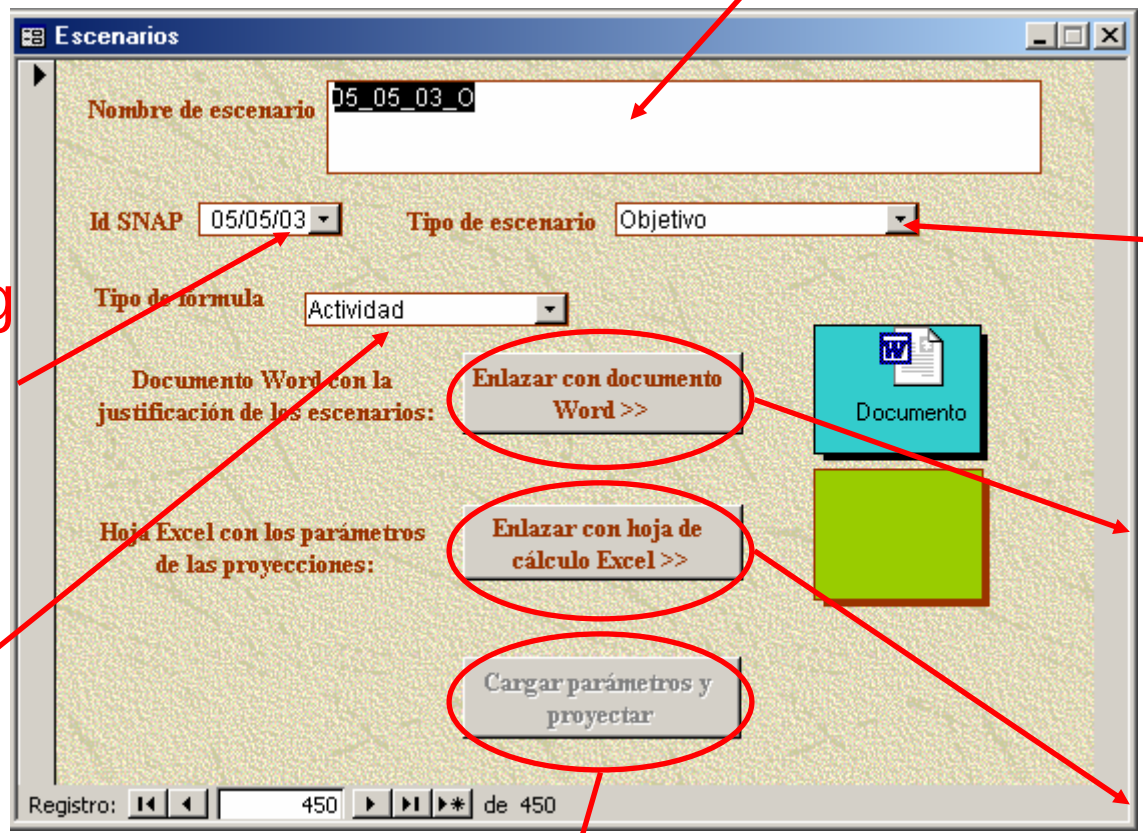

EmiPro
Consulta de datos origen
Edición de datos origen
EMI PRO 2
Editar proyecciones
Resultados
Salir
Créditos
Menú de edición de proyecciones
Proyecciones
EMI PRO 2
Editar tipos de escenarios
Editar macroescenarios
Editar ámbitos para macroescenarios
Editar escenarios / proyectar
Volver al Menú principal

- Scenario edition / projection dialog box -

Input box for scenario ID

Drop-down menu listing all valid SNAP IDs

Algorithm type selection



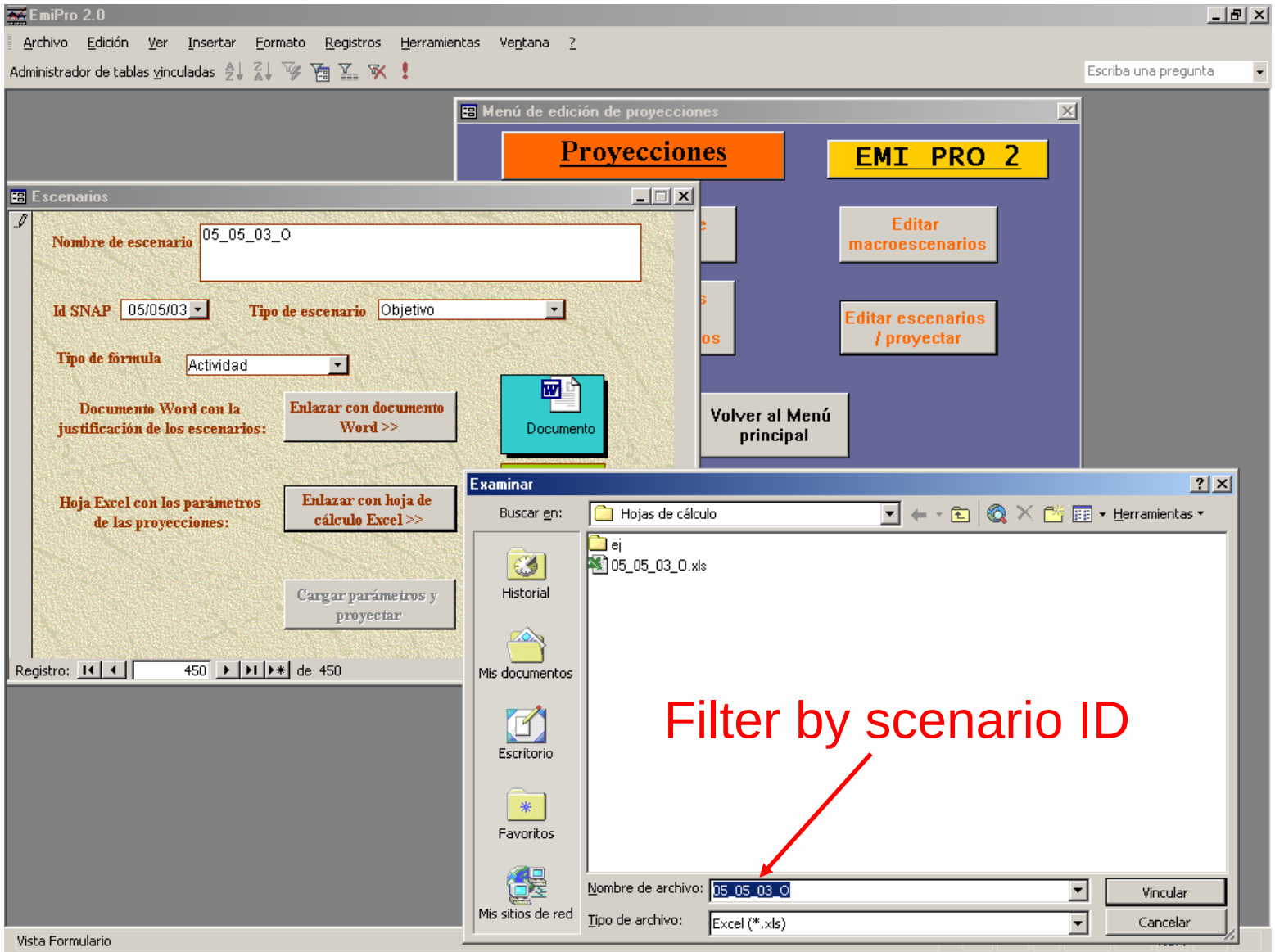
Type of scenario

Descriptive document for the projection

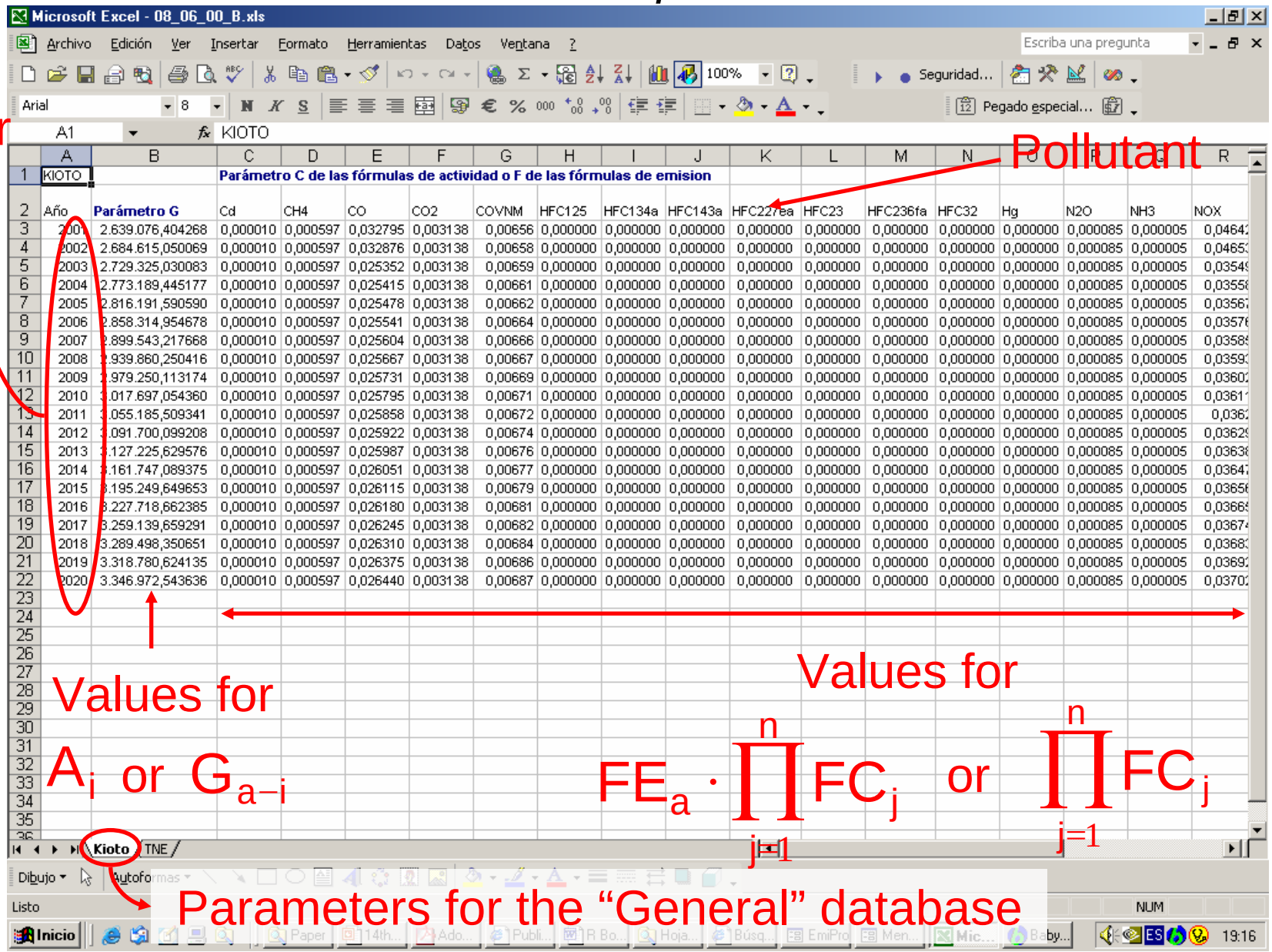
Parameters spreadsheet

Load parameters and project button
(*only available when all inputs properly supply*)

- Projection parameters input dialogue and browser-

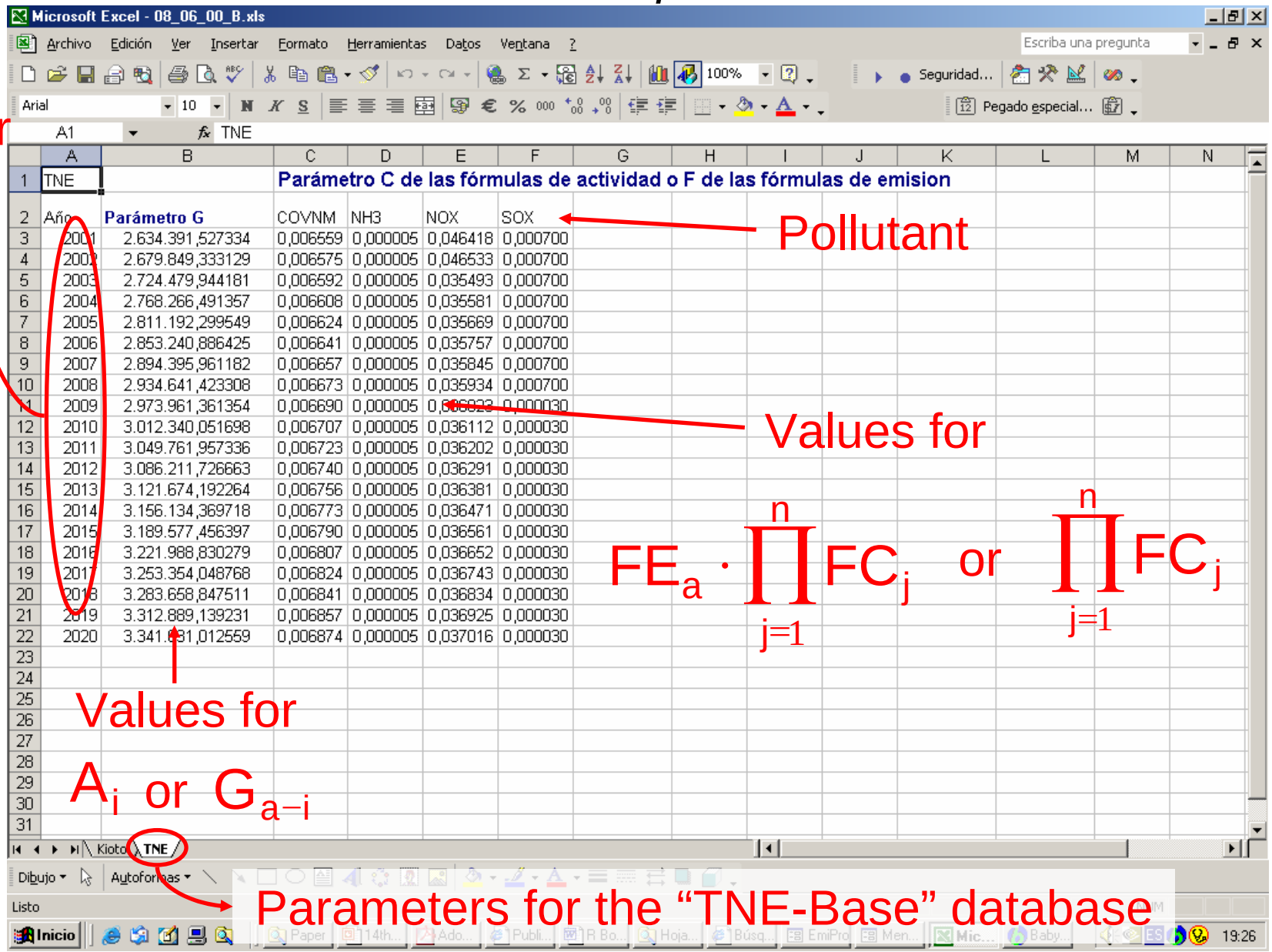


- Parameters spreadsheet -



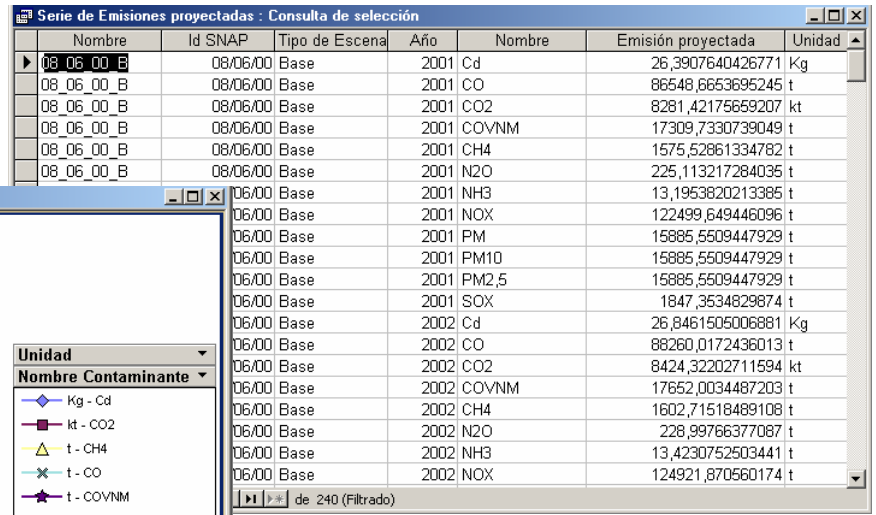
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
1	KIOTO		Parámetro C de las fórmulas de actividad o F de las fórmulas de emision															
2	Año	Parámetro G	Cd	CH4	CO	CO2	COVNM	HFC125	HFC134a	HFC143a	HFC227ea	HFC23	HFC236fa	HFC32	Hg	N2O	NH3	NOX
3	2001	2.639.076,404268	0,000010	0,000597	0,032795	0,003138	0,00656	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0464
4	2002	2.684.615,050069	0,000010	0,000597	0,032876	0,003138	0,00658	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0465
5	2003	2.729.325,030083	0,000010	0,000597	0,025352	0,003138	0,00659	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0354
6	2004	2.773.189,445177	0,000010	0,000597	0,025415	0,003138	0,00661	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0355
7	2005	2.816.191,590590	0,000010	0,000597	0,025478	0,003138	0,00662	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0356
8	2006	2.858.314,954678	0,000010	0,000597	0,025541	0,003138	0,00664	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0357
9	2007	2.899.543,217668	0,000010	0,000597	0,025604	0,003138	0,00666	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0358
10	2008	2.939.860,250416	0,000010	0,000597	0,025667	0,003138	0,00667	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0359
11	2009	2.979.250,113174	0,000010	0,000597	0,025731	0,003138	0,00669	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0360
12	2010	3.017.697,054360	0,000010	0,000597	0,025795	0,003138	0,00671	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0361
13	2011	3.055.185,509341	0,000010	0,000597	0,025858	0,003138	0,00672	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0362
14	2012	3.091.700,099208	0,000010	0,000597	0,025922	0,003138	0,00674	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0362
15	3.127.225,629576	0,000010	0,000597	0,025987	0,003138	0,00676	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0363
16	3.161.747,089375	0,000010	0,000597	0,026051	0,003138	0,00677	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0364
17	3.195.249,649653	0,000010	0,000597	0,026115	0,003138	0,00679	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0365
18	3.227.718,662385	0,000010	0,000597	0,026180	0,003138	0,00681	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0366
19	3.259.139,659291	0,000010	0,000597	0,026245	0,003138	0,00682	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0367
20	3.289.498,350651	0,000010	0,000597	0,026310	0,003138	0,00684	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0368
21	2019	3.318.780,624135	0,000010	0,000597	0,026375	0,003138	0,00686	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0369
22	2020	3.346.972,543636	0,000010	0,000597	0,026440	0,003138	0,00687	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000000	0,000085	0,000005	0,0370

- Parameters spreadsheet -



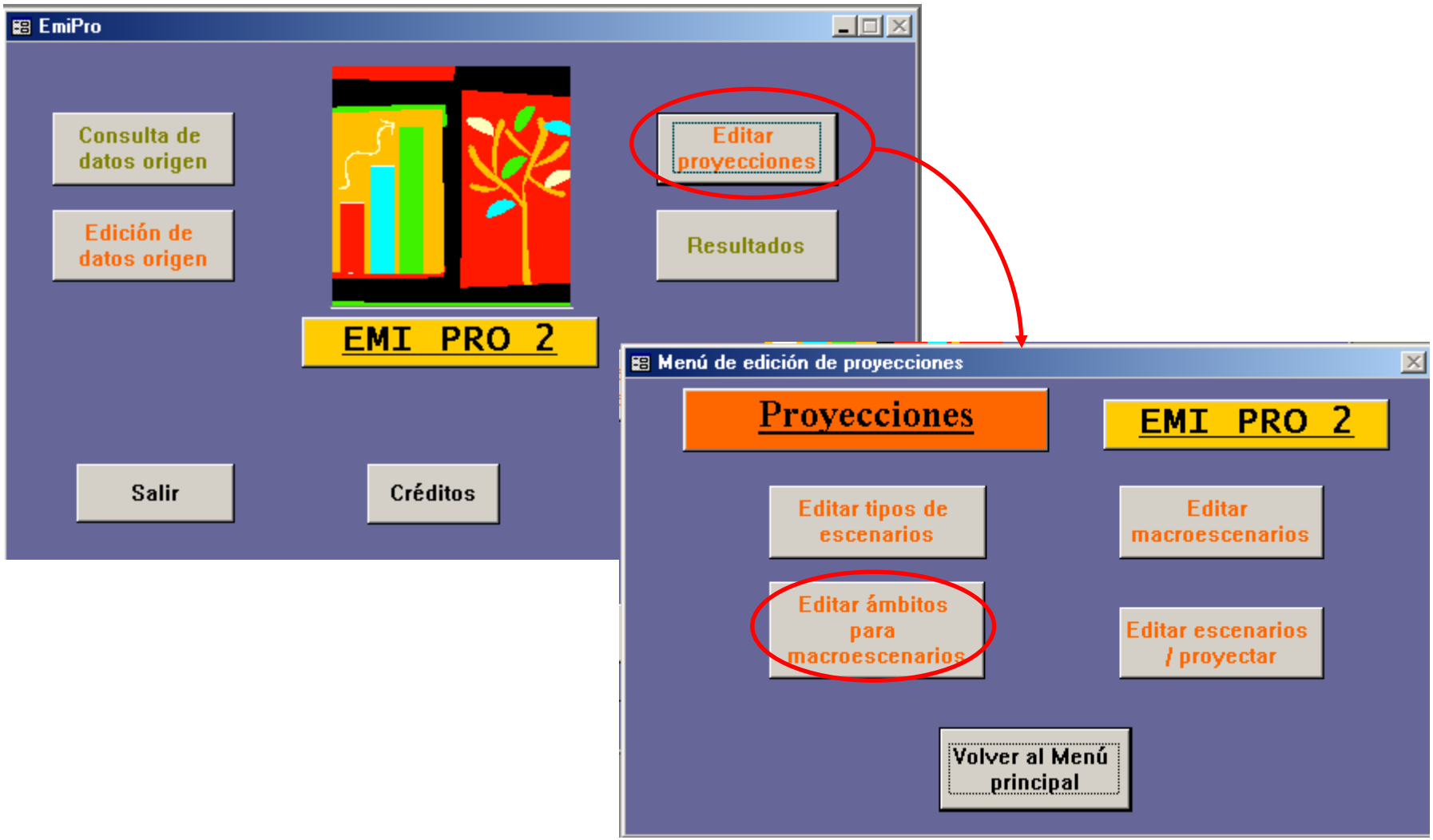
TNE	Parámetro C de las fórmulas de actividad o F de las fórmulas de emision				
Año	Parámetro G	COVNM	NH3	NOX	SOX
2001	2.634.391,527334	0,006559	0,000005	0,046418	0,000700
2002	2.679.849,333129	0,006575	0,000005	0,046533	0,000700
2003	2.724.479,944181	0,006592	0,000005	0,035493	0,000700
2004	2.768.266,491357	0,006608	0,000005	0,035581	0,000700
2005	2.811.192,299549	0,006624	0,000005	0,035669	0,000700
2006	2.853.240,886425	0,006641	0,000005	0,035757	0,000700
2007	2.894.395,961182	0,006657	0,000005	0,035845	0,000700
2008	2.934.641,423308	0,006673	0,000005	0,035934	0,000700
2009	2.973.961,361354	0,006690	0,000005	0,036023	0,000030
2010	3.012.340,051698	0,006707	0,000005	0,036112	0,000030
2011	3.049.761,957336	0,006723	0,000005	0,036202	0,000030
2012	3.086.211,726663	0,006740	0,000005	0,036291	0,000030
2013	3.121.674,192264	0,006756	0,000005	0,036381	0,000030
2014	3.156.134,369718	0,006773	0,000005	0,036471	0,000030
2015	3.189.577,456397	0,006790	0,000005	0,036561	0,000030
2016	3.221.988,830279	0,006807	0,000005	0,036652	0,000030
2017	3.253.354,048768	0,006824	0,000005	0,036743	0,000030
2018	3.283.658,847511	0,006841	0,000005	0,036834	0,000030
2019	3.312.889,139231	0,006857	0,000005	0,036925	0,000030
2020	3.341.031,012559	0,006874	0,000005	0,037016	0,000030

- After clicking the "*Load parameters and project*" button, reports on projections are available. Once all activities are projected, global reports –both graphical and numerical - may be generated

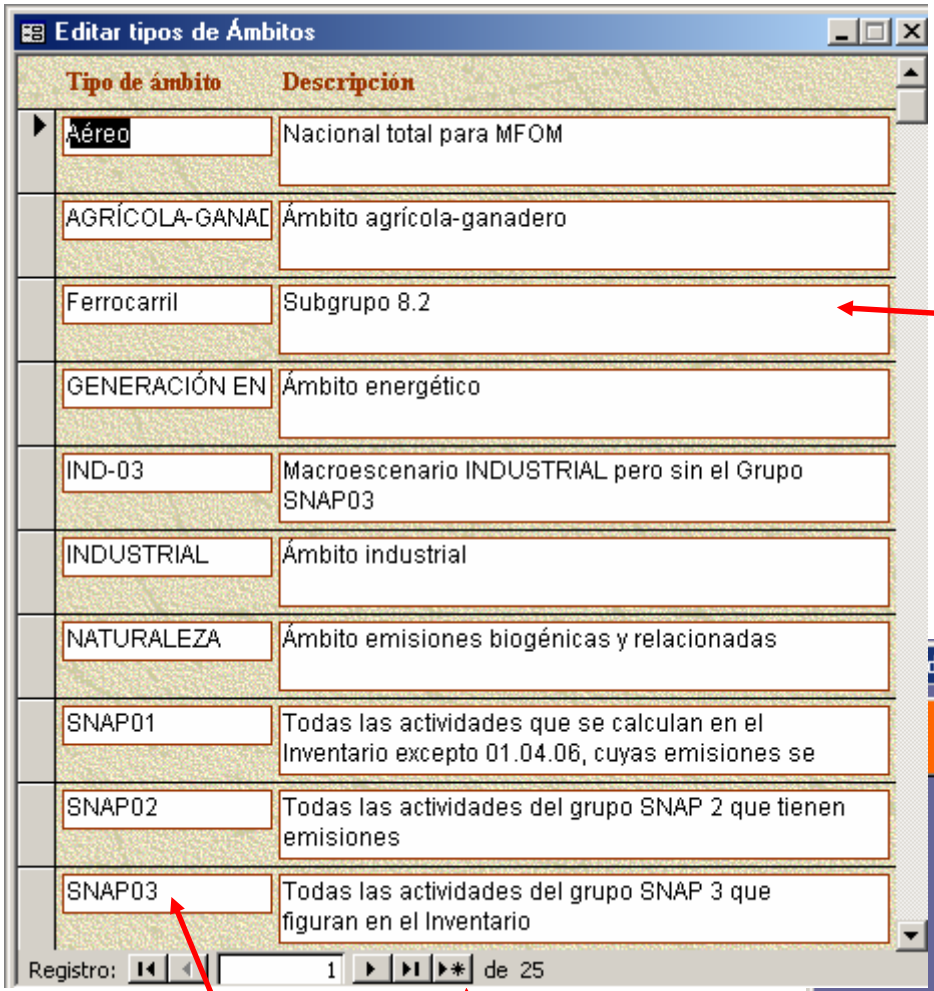


Macroscenarios

- Firstly, they must be defined by the user:

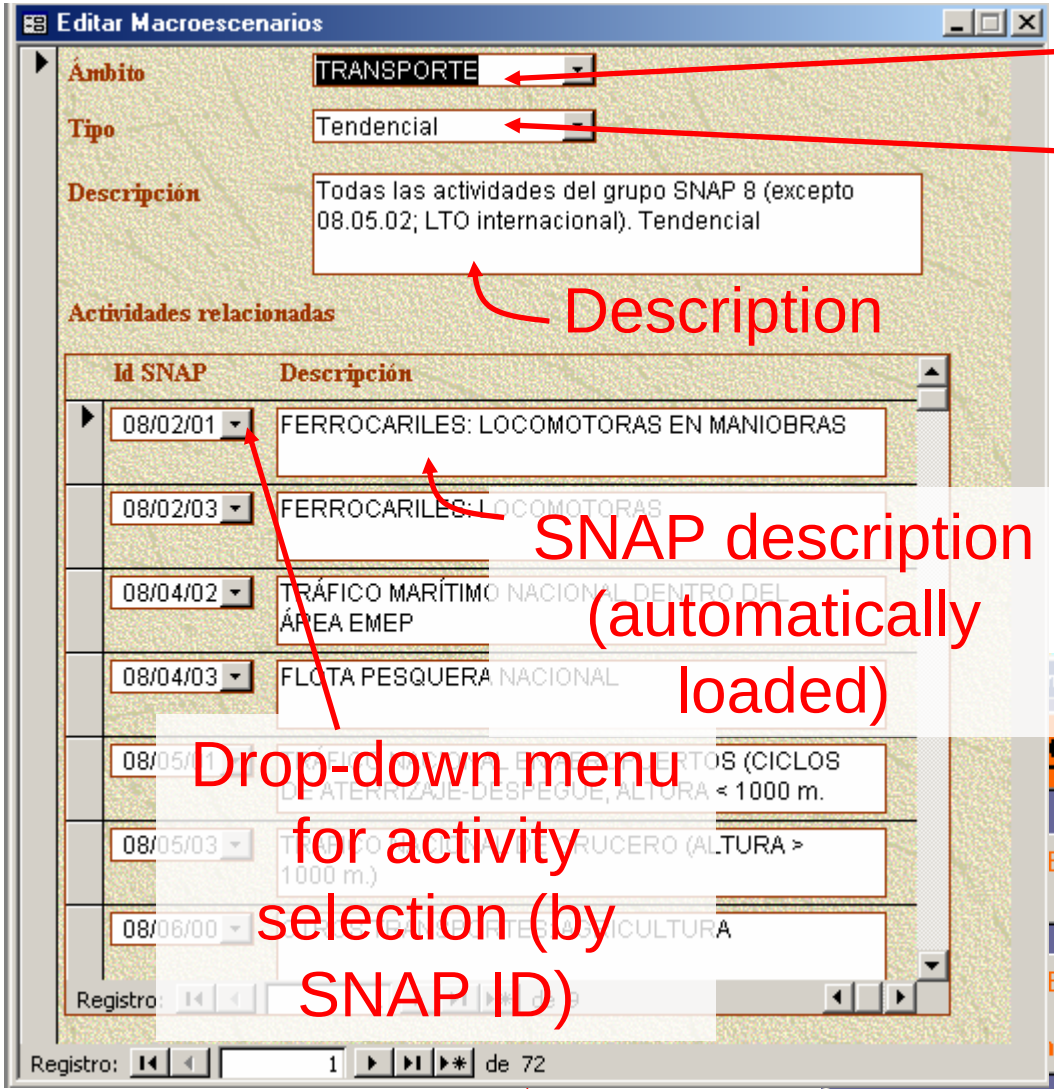


-Macroscenario definition screen -



Macroscenario brief description

Macroscenario ID



Macroscenario ID

Type of scenario

Description

SNAP description (automatically loaded)

Drop-down menu for activity selection (by SNAP ID)

- Once a macroscenario has been defined, it can be edited (which activities it includes)

-Macroscenario edition screen -

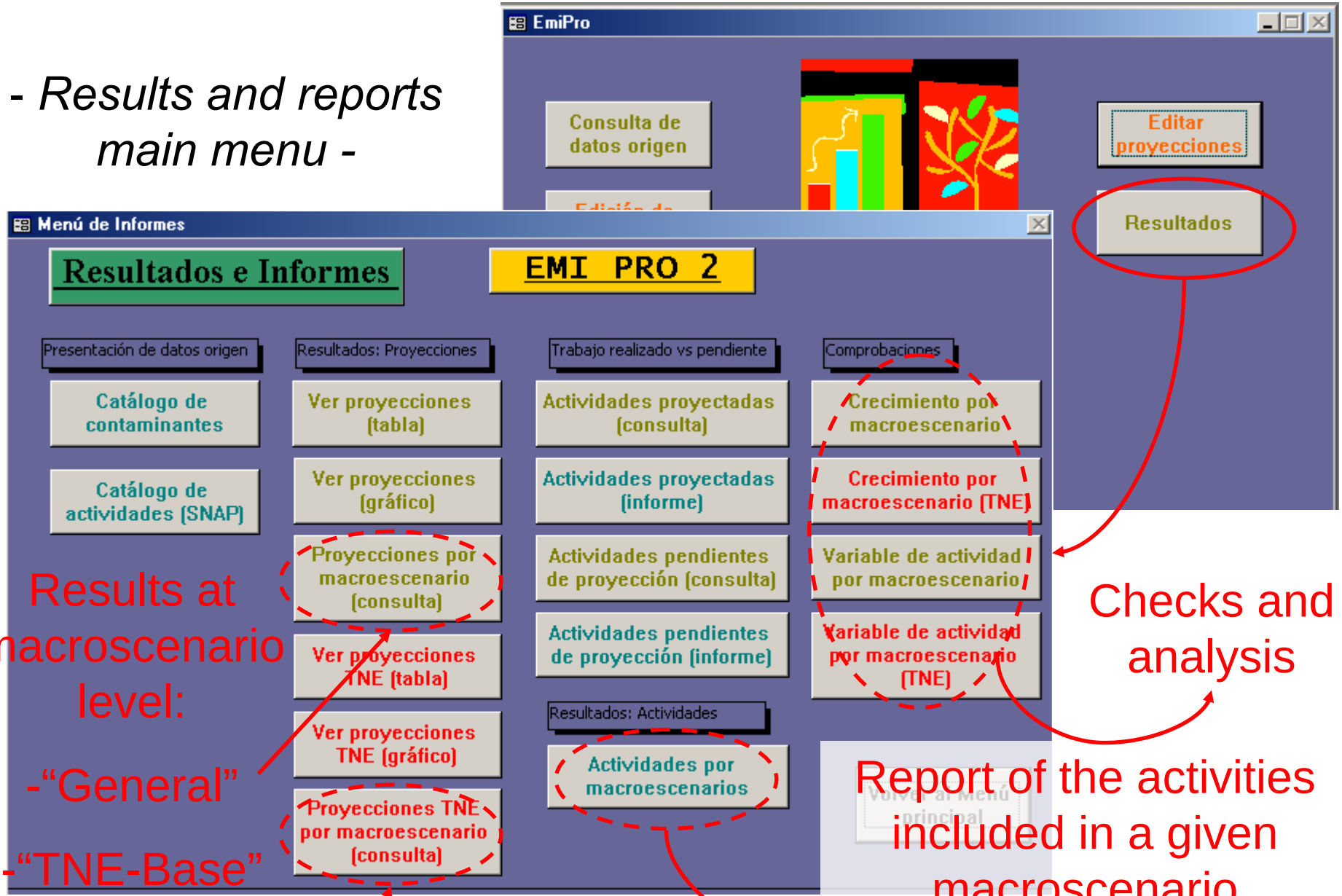
- The macroescenario concept is developed mainly to perform the QA/QC regarding hypotheses consistency
- However, it is useful also for other purposes:
  - Projection results aggregation (e.g. SNAP group or national total)
  - Translation of the results to report under other nomenclatures categories (e.g. Nomenclature for Reporting (NFR) of UNECE CLRTAP)

- Regarding the calculation of macroscenarios results, EmiPro uses an aggregation rule, depending on the type of scenario:

- If the scenario is "Baseline" or "Target", Emipro will look for the corresponding scenario at activity level. In case it doesn't exist, the results for the "BAU" or "Baseline" scenario will be retrieved in the query and added to the computation

- Beside from the results (either in tabular or graphic format), EmiPro will generate a report informing the type of scenarios included for each activity

- Results and reports main menu -



Results at macroscenario level:

-"General"

-"TNE-Base"

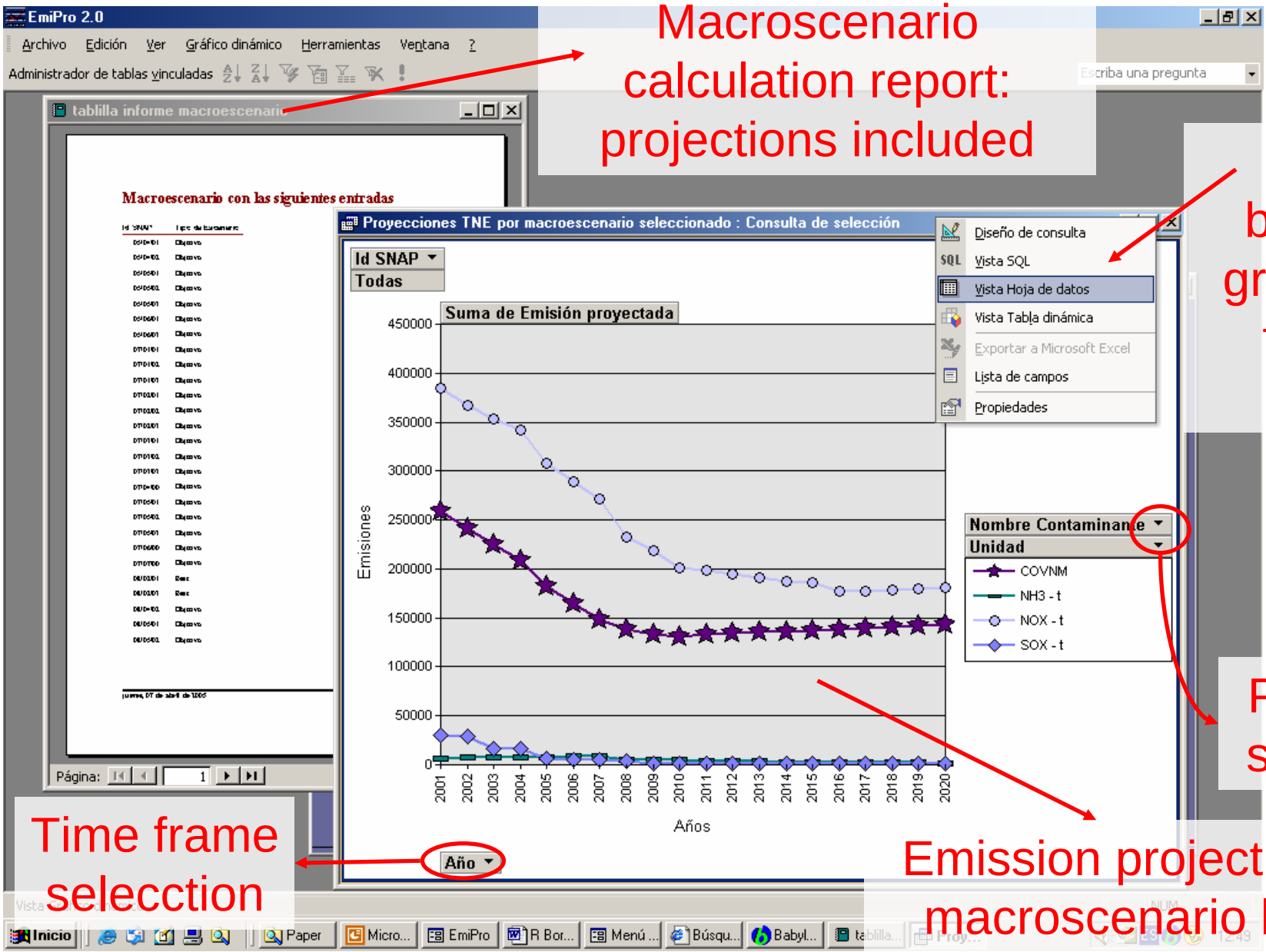
Checks and analysis

Report of the activities included in a given macroscenario

- *Macroscenario ID and type selection dialogue box* -

Drop-down menus for macroscenario and type of scenario selection

Calculate and visualize results



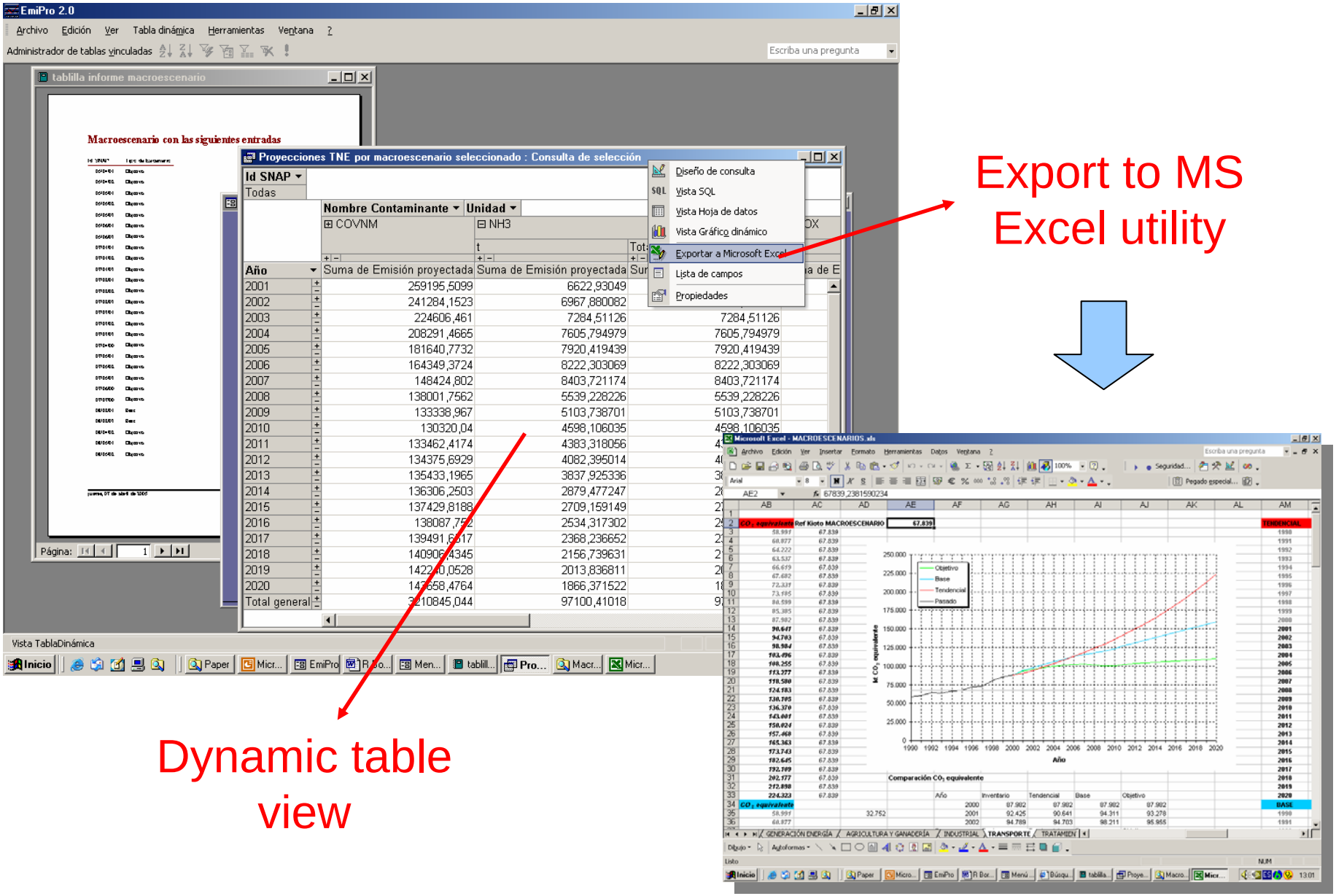
Macroscenario calculation report: projections included

Switch between graphical - tabular views

Pollutant selection

Time frame selecction

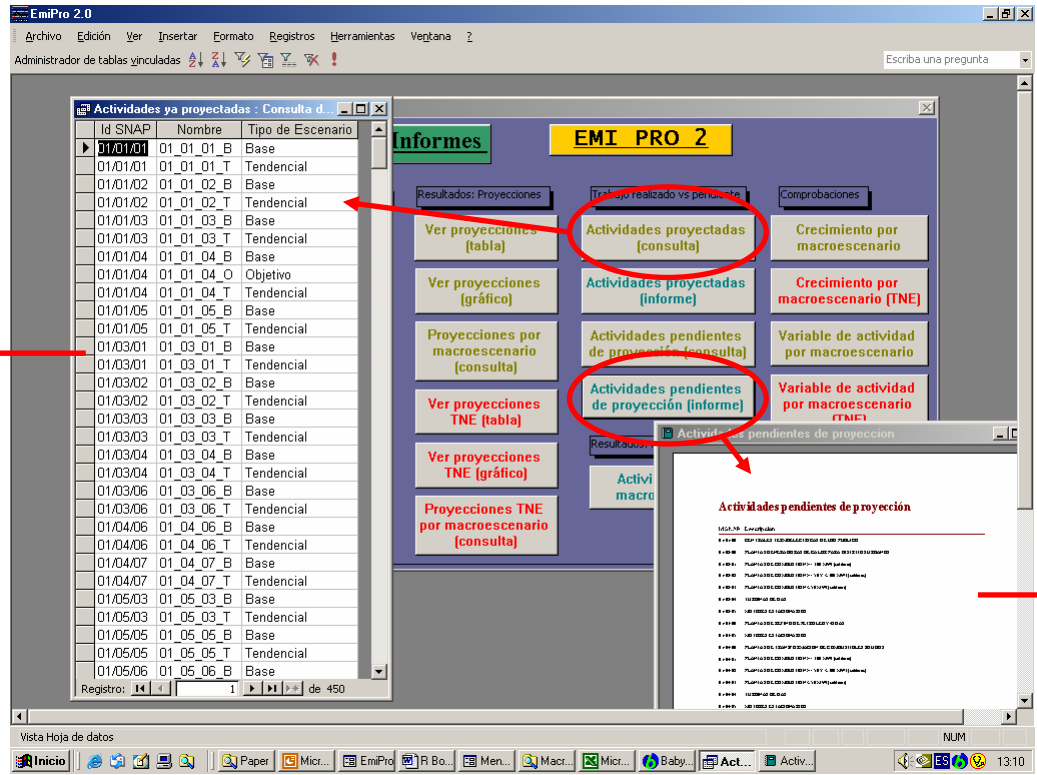
Emission projection at macroscenario level


EmiPro 2.0
Archivo Edición Ver Tabla dinámica Herramientas Ventana ?
Administrador de tablas vinculadas
Escriba una pregunta
tablilla informe macroescenario
Macroescenario con las siguientes entradas
Página: 1
Proyecciones TNE por macroescenario seleccionado : Consulta de selección
Id SNAP
Todas
Nombre Contaminante
Unidad
COVNM
NH3
t
Año
Suma de Emisión proyectada
2001 259195,5099 6622,93049
2002 241284,1523 6967,880082
2003 224606,461 7284,51126 7284,51126
2004 208291,4665 7605,794979 7605,794979
2005 181640,7732 7920,419439 7920,419439
2006 164349,3724 8222,303069 8222,303069
2007 148424,802 8403,721174 8403,721174
2008 138001,7562 5539,228226 5539,228226
2009 133338,967 5103,738701 5103,738701
2010 130320,04 4598,106035 4598,106035
2011 133462,4174 4383,318056
2012 134375,6929 4082,395014
2013 135433,1965 3837,925336
2014 136306,2503 2879,477247
2015 137429,8188 2709,159149
2016 138087,752 2534,317302
2017 139491,6017 2368,236652
2018 140906,4345 2156,739631
2019 142240,0528 2013,836811
2020 143658,4764 1866,371522
Total general 3210845,044 97100,41018
Diseño de consulta
Vista SQL
Vista Hoja de datos
Vista Gráfico dinámico
Exportar a Microsoft Excel
Lista de campos
Propiedades
Vista TablaDinámica
Inicio
Export to MS Excel utility
Dynamic table view
Microsoft Excel - MACROESCENARIOS.xls
Ref Kioto MACROESCENARIO
67,839
TENDENCIAL
Objetivo
Base
Tendencial
Pasado
Año
Comparación CO2 equivalente
Inventario
Tendencial
Base
Objetivo
BASE
GENERACIÓN ENERGÍA
AGRICULTURA Y GANADERÍA
INDUSTRIAL
TRANSPORTE
TRATAMIEN

Helper functions

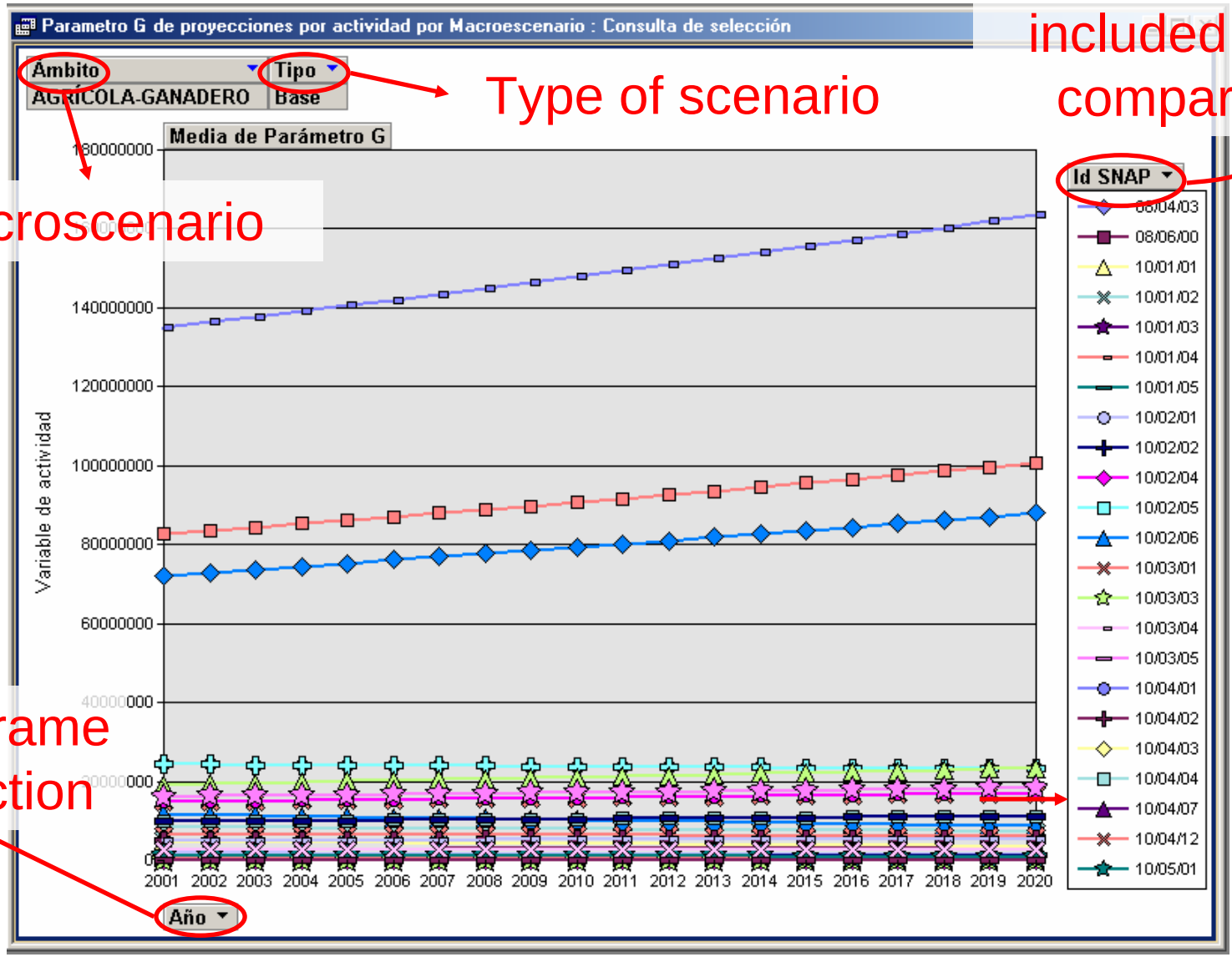
- The tool has some helper functions to make the tracking of tasks easier, as indicating the list of activities not yet projected for each scenario:

Activities / scenarios already projected (tabular form)



Activities pending for projection (report)

- *Activity-level activity rate path hypotheses plot* -



Activities to be included in the comparision

Type of scenario

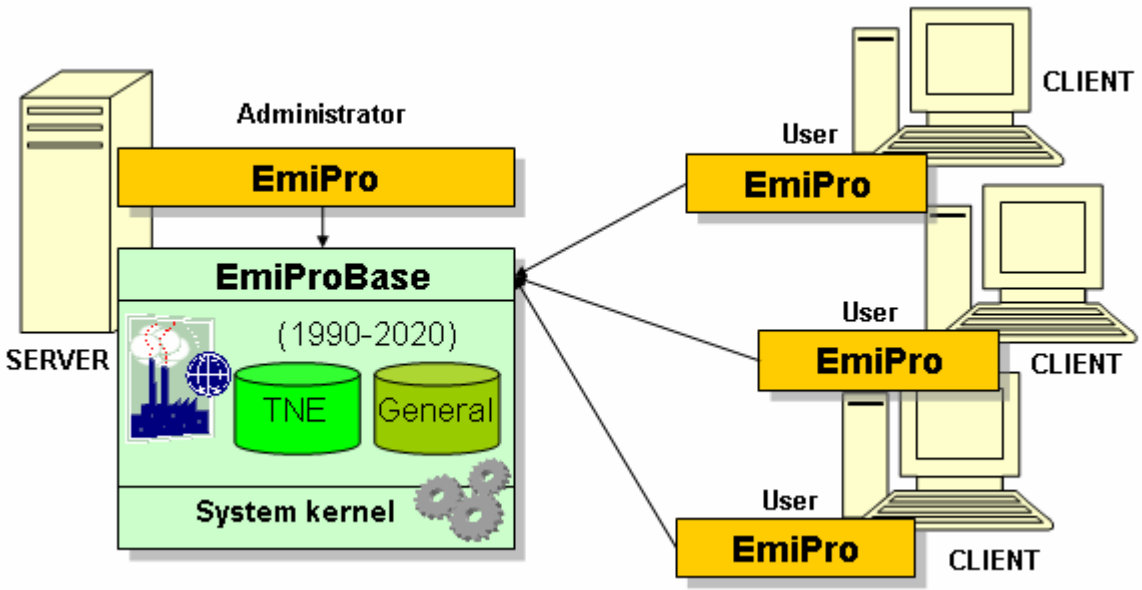
Macroscenario

Time frame selecction

Technology

- EmiPro is a MS Access built-on PC tool specifically designed to support the SEP project

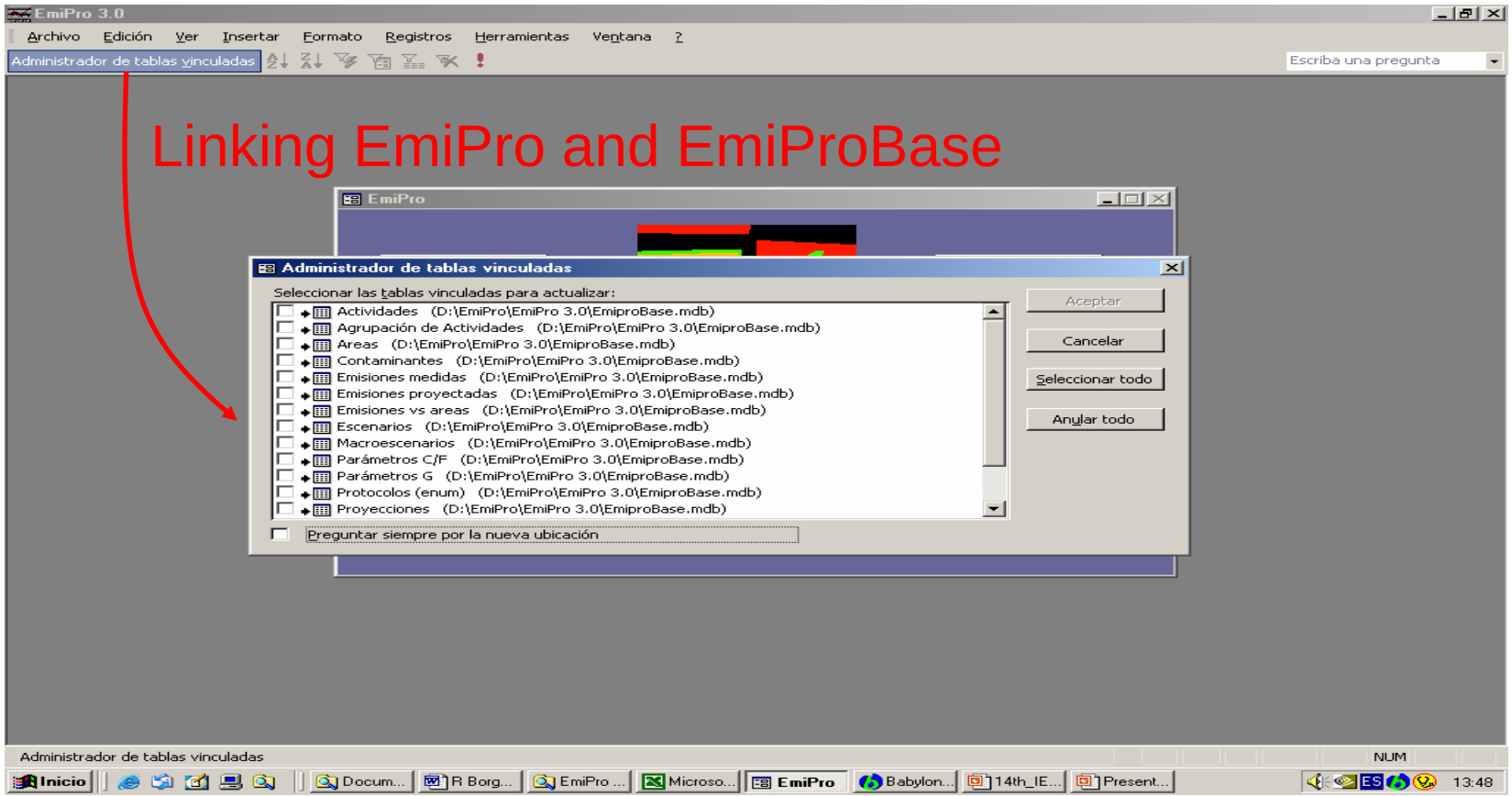
- It is intended to be used in a local area network under any MS Windows-NT based operating system.



- EmiPro is made up of two components:

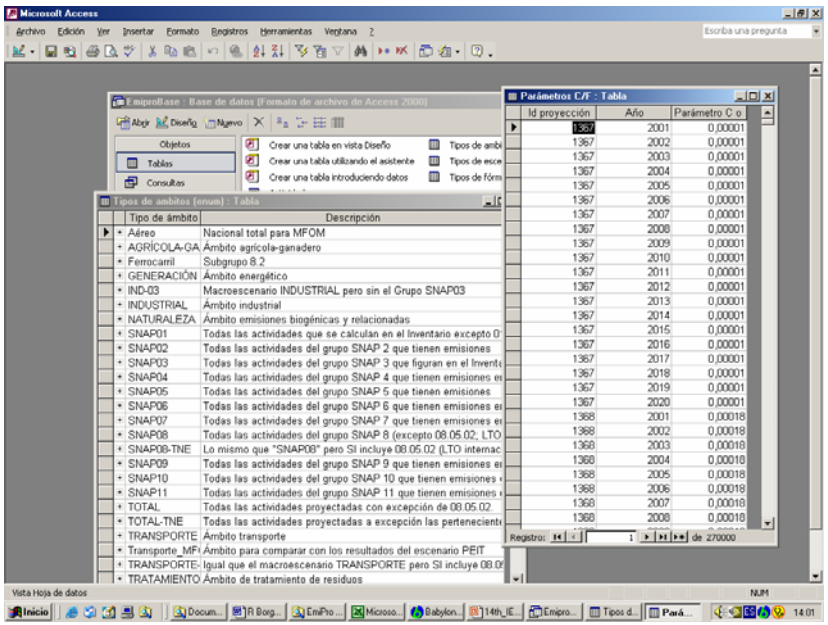
  EmiPro.mdb

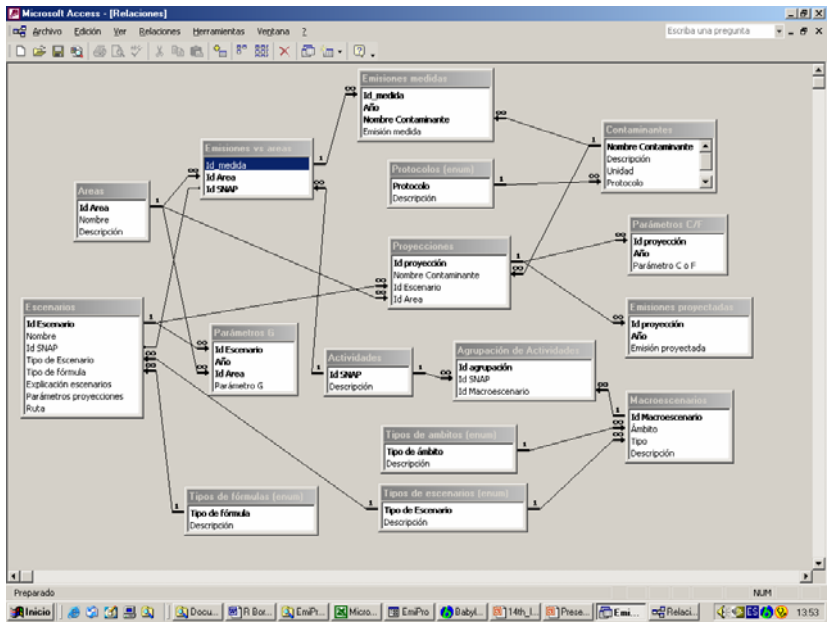
  - User interface to be installed in every client PC. Must be linked to the proper EmiProBase.mdb



EmiProBase.mdb

- Includes the kernel of the system and all the databases
- Resides in the PC acting as server
- It cannot be edited directly. The users are not allowed to access the raw data, so they must use the interface



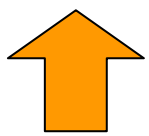


5. CONCLUSIONS

- The volume of managed data in the SEP project, both for the algorithm factors of the projections and the results of projections themselves revealed the need of a software tool to handle them
- EmiPro is a key element to guarantee the consistency and quality of the national projections
- Although this piece of software must be considered as a work in progress, it has shown to be very useful at data management, synthesis and analysis of the results inside the SEP project

- This tool can serve as a basis for the updating and revision of national emission projections

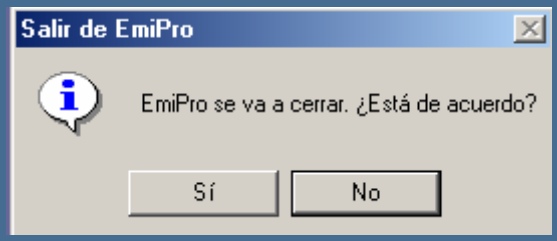
- Therefore, EmiPro could give support to the annual revision and publication of national emission projections, in coordination with the National Emission Inventory. This would help Spain's Environmental Administration to fulfill the information requirements at the scheduled time



6. NEXT STEPS

- Continuous revision and improvement of the performance, reliability and functionalities of the tool
- Basis for a tool capable of working as an interface with the RAINS model, which provides a bridge between national emission inventory and projections and the CAFE program
- Enhancement of its exporting capabilities in order to provide a consistent way to generate SMOKE-ready IDA ASCII format files, useful for modeling purposes

THE END



THANK YOU FOR YOUR ATTENTION

Any questions?

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