Evaluation of good practices impacts at the small to medium scale: the Friuli Venezia Giulia experience.

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Necessity to quantify impacts

For the evaluation of environmental impacts due to human activities, lifestyles or plans and programs it is essential the identification of measurable indicators that allow to link the activities we're talking about with the effects we're studying. The best choice of the index depends on the type of the impact we want to analyze.
The starting point for the evaluation of the efficacy of carried out actions consists in the quantitative assessment of selected indicators and of the identification of relations. These ones link indicators on the one hand with the processes and on the other hand with environmental effects, whatever it is the target (reduction of air pollution, reduction of energy wastes, reduction of ecological footprint etc.).
In fact, if we are not able to measure, we've no possibility to act and, on the other hand, if we are not able to identify which of the indicators is best to use and give a sense to collected data, we've no possibility to start specific and effective actions. [1]
Therefore, to face in an easy and synthetic way the problem of impacts' quantification, we can consider the equation introduced by Ehrlich and Holdren in 1971 (I = PxAxT) to determine the human impact on nature. This approach gives us a perfect synthesis and a starting point for our discussion. [2]
The impact of human being on the biosphere (I) is considered equivalent to three variables: P that represents population, A that represents “affluence” (opulence, comfort or goods' use) a term that refers to the amount of goods materials used by each individual for a certain period of time and T that represents technology, that is the technical quality of products (for example amount of polluting agents linked to production and to consumption of a certain quantity of goods material).
For the aim of this discussion the following formulation is useful:
Environmental impact = f(Population x Consumption pro capita x Impact per consumption's unit or emission factor).
This equation has the advantage to identify the three big macro-areas of action in which the analysis for the impacts' evaluation and the efforts for the reduction of impacts fall.

Thinking of the “population” factor, there are many considerations that can be reported. In fact, a no-impact life can't exist and so the number of inhabitants has a key role in the final result. However, in the following analysis we're going to see how the population factor can be considered in a positive way that is how a trivial action, with a limited effect, may become really important if applied on a large scale.
In this sense the reduction of environmental impacts could have a simple solution but the resistance of individuals to start actions that preview changes in their lifestyle.
“Affluence” or per capita consumption is the most interesting factor because of it's linked to lifestyles. It is this factor, in fact, that you have the greatest chance of action, while the more difficult.
In our culture in which “more is better” it is easy to confuse factors “amount of possessions” and “quality of life”. However in many occasions it was proved that when a individual has reached the material sufficiency his happiness isn't linked to his personal richness anymore (we can see as an example Vicki Robin's work).
There are also many other aspects of to the psychological sphere for which the projected

benefits have to get over in a large way the losses feared before a person could accept a change in its life. We can add to this the “asymmetrical principle” [3] a phenomenon linked to effects of actions started to reduce impacts. Those actions, in fact, can demonstrate the efficacy in different temporal and spatial moments with respect to the application point. The ethical implication is to accept that a sacrifice, seen as “comfort loss”, carried out by a person in a given moment, could have benefits that doesn't fall on the person itself, but probably on its children or, perhaps, on people of other countries.
The third aspect is the technological factor or the impact per consumption's units. It is define as “emission factor” in the case of impact of polluting substances. The technological factor has interesting implications in the impact definition. In fact, in spite of the search of the best technological efficiency is a viable and desirable strategy, reduce the input/output ratio doesn't necessarily lead to a decrease of the resources' use. The phenomenon called “rebounding mechanism” [3] leads to a sort of justification/authorization to the consumption also when it could be avoided.
Technology can give a great contribution for the reduction of environmental impact, if we use it in a correct way, but the savings that come from that must not be used for other consumption forms.

Assessment of impacts of plan actions or good practices

In this chapter we're going to analyze the effects of two possible actions foreseen for the reduction of air pollution. The Regional Center for Environmental Modeling of ARPA FVG has carried out the analysis for the technical support to the Region for the compiling of Regional action Plan.

– Reduction of internal temperature of buildings during winter

The first considered action is the reduction of internal temperature of buildings during winter from a statistically assumed value of 20°C up to 18°C. The action can be easily applied, when we have heating with boiler, setting up the thermostat to 18°C.
Following the already introduced IPAT model, action's factors take shape in these ways:
P = population who carries out the action. The measure is applied all over the regional territory;
A = per capita consumption. The variation in the internal temperature is translated into variation of fuel's consumption for heating. To calculate this variation, we analyzed the relationship between the consumption of natural gas in two cities (Trieste and Udine. Data AMGA and ACEGAS, November 2007, 2008 and 2009) with the average outside temperature. We can observe a linear dependence between two quantities: there is a 6% increase of natural gas's consumption every 1°C reduction of external temperature. Since the transmission of heat is related to the difference between the external and internal temperature to buildings, the same relationship can be used to estimate the savings of the consumption of methane obtainable by applying a decrease in temperature inside buildings: reducing the average temperature of two degrees internal of buildings could reasonably expect a decrease of methane consumption by more than 10% [4]. Values concerned with methane's consumption are given by local operators and spatialized in the territory to appropriate proxy. INEMAR [9] is the emission inventory and is the software used for this operation. Through this software, you can also estimate the emissions of pollutants by the use of natural gas for heating.
T = technology. In the elaboration of given data, a particular type of boiler wasn't considered. The technological evolution has, however, led to the construction of boilers with always greater performances (eg condensation boiler) that, to highlight their efficacy

have to be installed in houses built with energy saving standards. Thinking about biomasses combustion for domestic heating, lots of working groups [5] are evaluating the sustainability of different types of devices and fuels used highlighting the significant difference in impact between different scenarios considered.

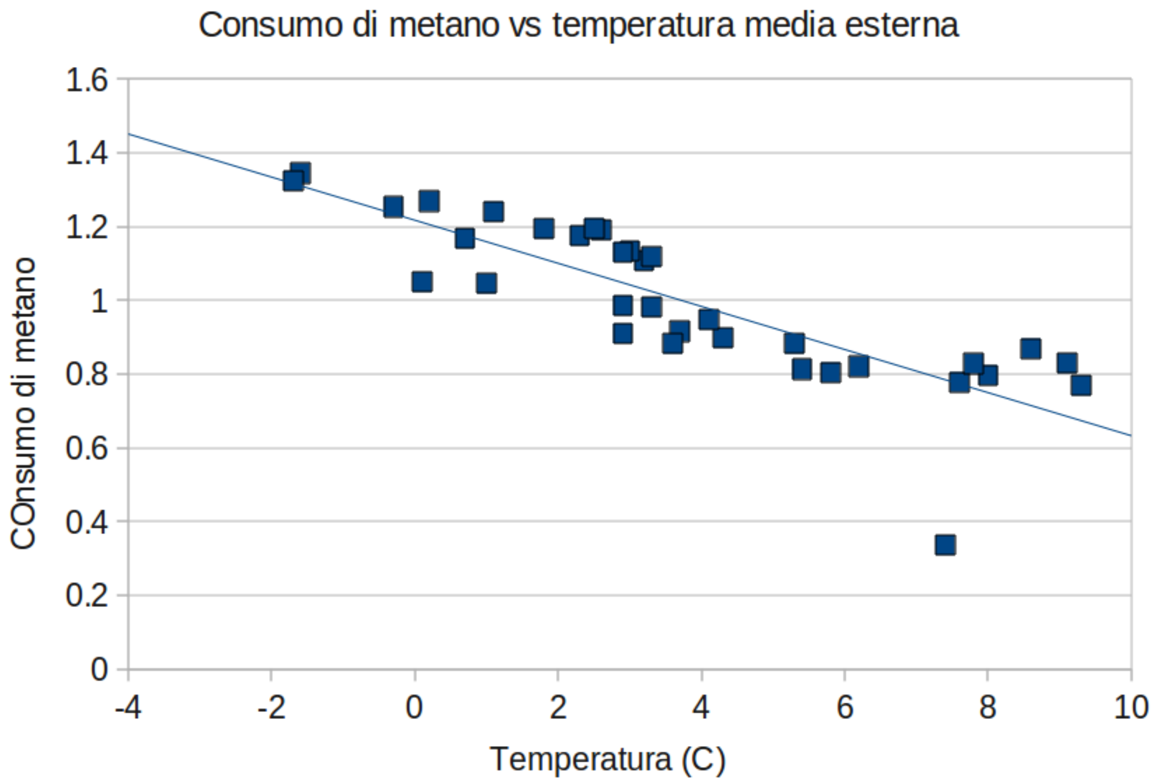

Figure 1 Relation between consumption of natural gas for home heating and average outside temperature. AMGA ACEGAS data for the cities of Udine and Trieste in November 2007, 2008 and 2009 [4].

I = impact assessment of good practice which is intended as a change in the state of air quality. Are considered two indicators: concentration of PM_{10} averaged over the month of January and 95th percentile values of concentration of the pollutant over the same period.
For the quantification of the impact is used a model of pollutant dispersion type Eulerian photochemical with a resolution of 4 x 4 km^2 [4] [10]. The model is applied to a squared domain with a side of 200 km centred on Friuli Venezia Giulia territory. The input data required are: the characterization of the weather on an hourly basis, the boundary conditions in terms of concentrations of pollutants, emission sources in the domain.
The analysis process involves two steps: the simulation of hourly concentrations of PM_{10} in the month of January with the unperturbed emission sources (scenario S0) and simulation of hourly concentrations of PM_{10} on January performed by reducing the emission of pollutants due to domestic combustion of 10% of the whole region (scenario S1). The difference in concentration ΔS between the two scenarios provides the impact of the action. We calculate the monthly average of ΔS and the 95th percentile of hourly value of ΔS in post elaboration.

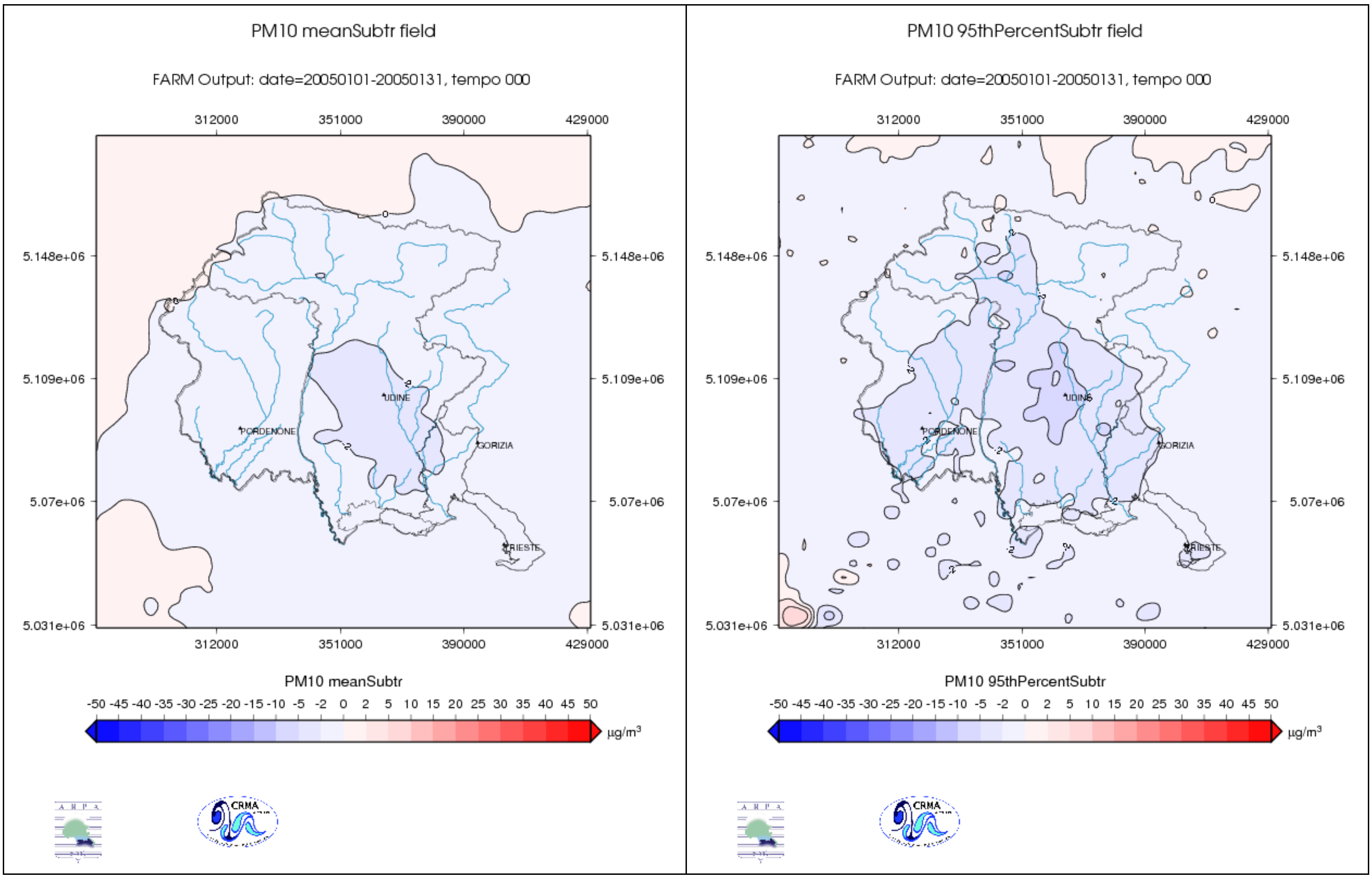

Figure 2. Representation ΔS impact on concentrations of fine particles as a result of the reduction of two degrees of heating. In the left panel shows the monthly average, in the right panel the 95th percentile [4].

Through the good practice of reduction of internal wintry temperature of two degrees it is possible to reduce from 2 to 5 µg/m^3 monthly concentrations of PM_{10} for the most part of region's central plain and to reduce of more than 5 µg/m^3 the peak values.

To assess the impact's importance of the good practice considered it can be useful a comparison with the impact of a drastic action applied to a more limited area. In this case, we simulate the zero emissions associated with provincial capitals. We're talking about emissions valuated with the INEMAR model in Udine, Pordenone, Gorizia and Trieste. These are cities with a minimum of 35,000 and a maximum of 220,000 inhabitants.
This hypothetical action isn't feasible and its effectiveness is verifiable only using a numerical simulation. The total closing of the provincial capitals would involve a reduction of concentration of fine particles comparable with the one of the action on the domestic heating. However in this case the efficacy would be limited to the area of the city.

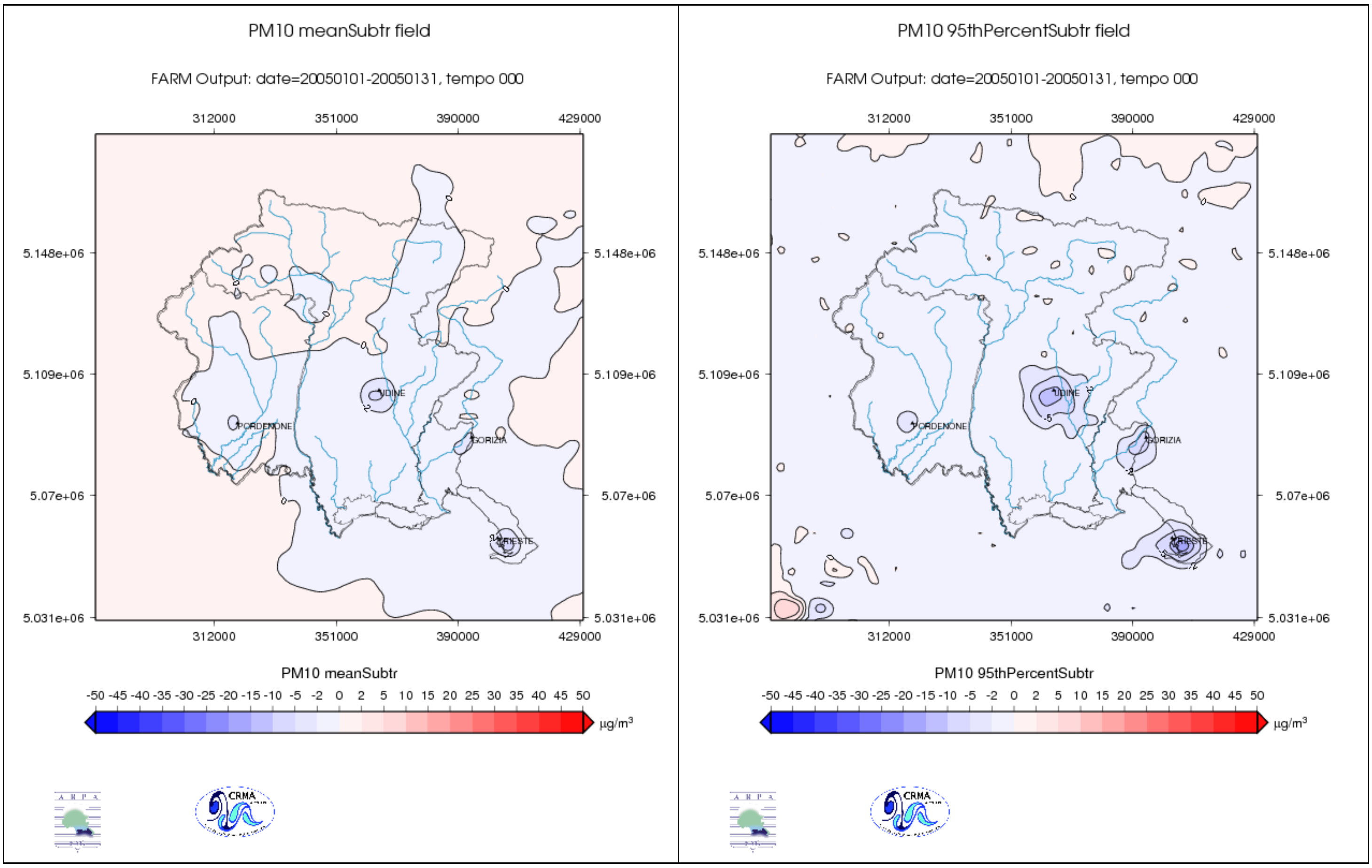

Figure 3. Map representation of the reduction of the concentration of fine particles due to an hypothetical total closing of the emissions of the provincial capitals [4].

In some cases, the accomplishment of an action aimed to the reduction of impacts produces improvements in places that aren't the one where the action was done. As an example, we can mention the impact on ozone for a hypothetical closing of region's industrial activities. The chosen index gives the variation at 95th percentile of hourly ozone concentrations simulated for the month of July. We can notice that in the application points of the action, that are the areas where we can find the main industrial sources, the ozone concentration increases while we can observe improvements in mountainous areas.

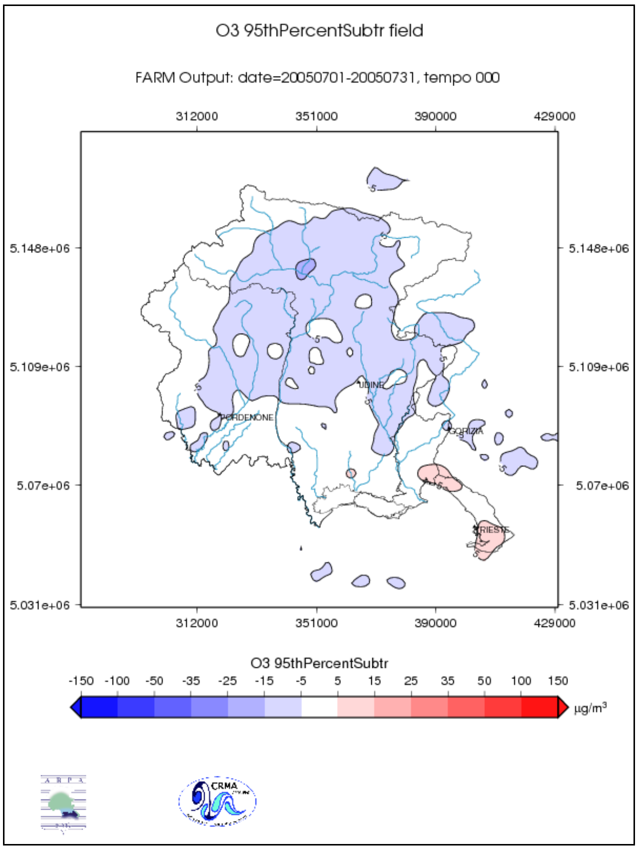

Figure 4. Representation of changes in the 95th percentile of ozone concentrations in July simulated assuming the closing of industrial plants all over the region [4].

–Use of cycle track

The construction of cycle track is a structural action that doesn't directly depend on the willing of the citizen but it's linked to the plans and programs of local administrations.
On the other hand the use of a cycle track is directly linked to the citizen's lifestyle. For this action it's possible to quantify impact on air quality too, but in emissive terms.
In this case we have:
P = factor equal to the number of people, potential users, of the cycle track. As an example, we consider the population living in the municipality of Udine (which has a network of 40 km of cycle track) to 31.12.2011.
A = per capita consumption. We consider the annual average use of cycle track per capita, in Italy, that is 168 km/year. [6]
T = technology. It is possible to use the right emissive factor for each polluting substance and for each car typology. Considering the average factor of nitrogen oxide's emission from petrol cars (limits of emission for EURO standards), weighed on the Italian fleet as reported in the statistical yearbook ACI 2012 [7], we obtain an emissive factor for oxides of nitrogen of 0.4 g/km.
I = the impact calculated for this action is the variation of emissive load due to the use of bicycle instead cars in the municipality of Udine. To simplify calculation, we can suppose that all bicycles users have chose not to use their petrol car. So we calculate the quantity of saved nitrogen oxides. Considering that we don't know P factor, we can show the relation about emissive load in function of the potential number of users.

I [g/year]= P [number of users] x 168 [km/year] x 0,4 [g/km]

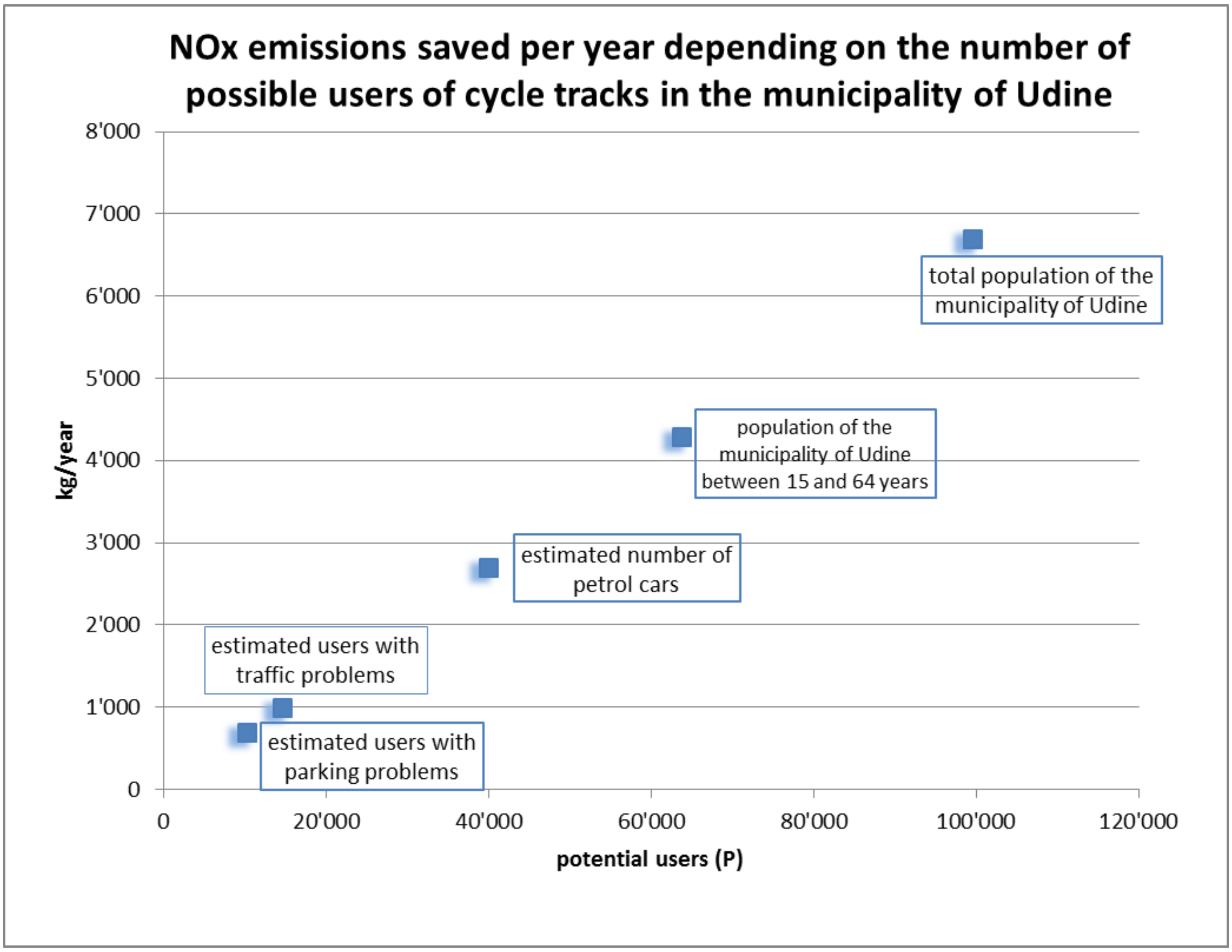

Figure 5. Relationship between number of cycle track users and estimate of nitrogen oxide emission saving.

The graphic in figure 5 report P values in abscissa (potential users) and the quantity of nitrogen oxides saving in kg/year in ordinate. There are some points that can be considered important, that are obtained applying to the estimate of municipal users who have petrol cars: the statistical data relative to percentage of families that highlight parking difficulties (25,7%) and traffic problems (36,6%) in Friuli Venezia Giulia. In the graphic there is also reported the number of Udine's inhabitants with an age that goes from 15 to 64 years (64%) and the total number of inhabitants to 31.12.2011 (99'627) [8].

Conclusion

Quantitatively evaluate the impact of good practices is necessary and possible. The choice of indicators and indices that can be used for quantification is decisive for the evaluation of action's efficacy and their monitoring. The IPAT model can be used as guide for the actions' analysis and it permits to indicate macro-areas (population, per capita consumption and technology) on which we can focus attention both to quantify actions' efficacy and evaluate their real accomplishment. The use of numerical models for the estimation of selected indicators permits to highlight intrinsic characteristics of effects of some actions. For example we can quote the advantage in the application in a large area of a good practice instead the accomplishment of local drastic actions or the acceptance of the paradox that the benefit of a mitigate action falls in different places from those linked to the application of the action itself.

Biography

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